PROBLEMS OF EVOLUTION

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BY

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'THE STRUCTURE AND LIFE OF BIRDS'

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Preface

In this book I attempt to find a solution of some of the most difficult of the problems of evolution. First I try to show that Lamarck's explanation of evolution will not bear investigation. But if the dovetailing of species into their environment has not been brought about, as he maintained that it had, by the moulding influence of the environment itself and the development of the organism by exercise, how have adaptations been effected? To account for them, the Neo-Darwinian, the follower of Weismann, has at his service only variations—he assumes that a tendency to vary pervades the whole organic world—and, as a regulating principle, Natural Selection. Nothing further, as I hope to make clear, is wanted to account for all the niceties of adaptation. Moreover, evolution appears to follow certain lines, and species group themselves in orderly series. This becomes intelligible, if we realise that all species, even the lowest, to a certain extent, pilot themselves. In other words, heredity limits the range of variation, and limits it more narrowly as evolution advances.

Sexual selection and isolation present problems, which though perhaps of less importance, are of the utmost interest.

The second part of the book deals with human evolution.

I assume that the principles which have brought about the evolution of plants and of animals other than man must account, no less, for human evolution. But no sooner is the human stage entered upon than morality, religion, and the accumulation of knowledge begin to play, each of them, an important part, which becomes more important as evolution proceeds.

Though progress in civilisation is quite distinct from evolution, it can be shown nevertheless that the former, to a considerable extent, guides the course of the latter. It tends to produce physical degeneration, but a higher morality. It is important, therefore, to discuss the conditions which favour progress, and this naturally suggests the subject of China and its unprogressive people, of which I have written in the last chapter. I completed this chapter before the Boxer outbreak, and have decided to add nothing to it.

The problems, as anyone who reads this preface will see, are big and very difficult to solve; but all are so full of interest, and some of such practical importance, that any help towards their solution is of value.

I have prefixed an introductory chapter, explaining some elementary biological facts, without a knowledge of which the general reader might not be able to understand what follows. Throughout I have avoided technical words as far as possible. The few that I have used are, I believe, all explained in the text, and in the index references to the pages, where the explanations are to be found, are distinguished by an asterisk.

Where I am indebted to other writers, I believe I have in all cases acknowledged my indebtedness. I had practically finished this book before I came across Professor Mackintosh's work, *From Comte to Benjamin Kidd.* Hence there is very little in the way of direct reference to it. However, the difficulties he raises with regard to evolution on Neo-Darwinian lines are not new to me, and I have dealt with them to the best of my ability.

It only remains for me to acknowledge gratefully my obligations to friends. Fig. 10 is from an original drawing by Mr C. G. C. King, and several of the other illustrations are copies by him from the originals. Fig. 11 is from a photograph by Mr E. T. D. Francis. Mr M. D. Hill has read the manuscript of Chapter I. Mr E. L. Gowlland has read the proofs from end to end. If I make no formal acknowledgment of the kindness of friends who have always been ready to discuss the problems I have attempted to grapple with, it is not because I forget how much I owe to them.

F. W. HEADLEY.

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PROBLEMS OF EVOLUTION

PART I

INTRODUCTORY

I

DARWIN'S THEORY

THIS chapter deals with elementary facts that are familiar to every biologist, and is intended for the general reader, to whom, it is hoped, it may be of service.

Evolution and Darwinism are not synonymous terms. Darwin gave his theory to the world in 1859; long before this, Lamarck had propounded a theory of evolution, *i.e.*, an unfolding of the higher forms of life, animal and vegetable, from the simpler. According to Lamarck, all species have become what they are through the moulding influence of external conditions (such as food, climate, etc.) and of exercise: from these two sources arise all variations, and characteristics thus acquired are handed down to succeeding generations. This was not accepted by men of science. Darwin's work was, not to originate the idea of evolution, but to show by what means it had been brought about. This means he called the struggle for existence, to the action of which was due an unceasing natural selection. The proposition which he set himself to work out is as follows:—

(1) *The offspring of all organisms, whether animal or vegetable, tend to resemble their parents.*

(2) *The young are never exactly like their parents, but there* is always some variation. The variations are mainly "spontaneous" (by which term he meant that we cannot discover the cause of them), and, to a less extent, due to the manner of life of the parents and the environment in which they live, characteristics thus acquired being handed down to the next generation.

(3) More young are born in every species than would be required to keep up its numbers, supposing that there were no natural check at work to prevent increase. He instanced especially the elephant, the slowest of breeders. If allowed to multiply unchecked, elephants would soon people the earth.

(4) In the struggle for existence all favourable variations are singled out for survival by Natural Selection, which acts in the same way as artificial selection. And thus, as the breeder has produced the many varieties of domestic pigeons, nature has produced all the many species of the animal and vegetable kingdoms. Sexual selection supplements Natural Selection.

Evidence that evolution has taken place

(1) The science of embryology has shown that each individual in one of the higher species of animals goes through many of the stages through which, according to the theory, the species has gone in the process of evolution.

In scientific language this may be expressed thus: the ontogeny, the development of the individual, as it proceeds, recapitulates briefly the phylogeny, the history of the evolution of the species. Thus man is at first a one-celled Protozoon, then an agglomeration of undifferentiated cells; at a later stage he has gill slits, like those of a shark, though no functioning gills.

(2) Palæontology shows an advance from the lower to the higher forms. We find:—

(*a*) In the primary rocks fishes and amphibians, and in the most recent of them some reptiles.

(*b*) In the secondary rocks reptiles are dominant on land, in the sea, and in the air. Pterodactyls, winged lizards, some small and some large, are kings of the air. But birds are beginning to appear. There is the archæopteryx, a true bird with many reptilian characteristics, found as a fossil in the Bavarian lithographic stone, and the toothed birds of America belong to this period. Small marsupials, allied to the existing kangaroo, are the only mammals.

(*c*) In the tertiary, birds of a less reptilian type are found in every quarter of the globe, but dominant everywhere are the *higher mammals, called from the manner of their growth as embryos, Placental. In this period it may be considered as*

proved that man already existed: he had already been developed, according to the theory, from a lower ape-like form, now extinct. Flint instruments, showing unmistakable signs of human workmanship, have been found in deposits that belong to a preglacial age.[1] Apart from such proofs it is evident from the stage of development that man had reached at the beginning of the quaternary period that he must already have been man, properly so-called, in the tertiary.

If we subdivide the tertiary period into three, we find further evidence of evolution. In the first of the three, the Eocene, we find animals and plants belonging to families now existing. In the second, the Pleiocene, existing genera are represented, but not yet species that are still extant. Finally, in the third, the Pleistocene, we find animals (among them man) and plants representing species that are now living upon the earth.

(*d*) In the quaternary age existing species are found in abundance, and frequent evidence of man appears.

(3) There is the evidence of comparative anatomy and physiology. An impartial anatomist must put man at no great distance from the higher apes, whether he compares their bony skeleton, or their bodies generally. Even their brains agree in structure, though in man the development is enormously greater. Comparative physiology shows that the processes of life in all animals are, roughly speaking, the same: all of them take in protoplasm as food: all of them make use of the oxygen in the atmospheric air or of that dissolved in water in order to oxidise the tissues they have built up, and so produce heat and energy. There is one mode of reproduction common to all.

(4) The present geographical distribution of animals and plants is explicable on the theory of the gradual evolution of species (beginning at some one centre) and their gradual dispersal to all accessible regions. Whereas, on the theory of special creation, why have oceanic islands only those animals which had the power of making their way thither over the

[1] *See Natural Science for April 1894, Nov. 1897, Jan. and Feb. 1898. The controversy seems to prove conclusively the existence of Plateau Man.*

sea? Of all mammals, why is the bat the only one truly indigenous in New Zealand?

Of these arguments Nos. (1) and (2) are the most convincing. On a theory of separate creations the preliminary embryonic stages of man, during which he belongs to various other classes of animals in succession, are superfluous and unaccountable. The evidence of Palæontology compels us to conclude either that there were numbers of separate creations at different periods (mammals, for instance, being introduced when the earth was peopled with lower forms), or else that evolution has taken place. But embryology forbids us to accept the alternative of separate creations, so that evolution remains as the only possible explanation of the facts.

Arguments in support of Darwin's theory

Artificial selection in the course of many centuries has produced very divergent breeds of horses, cattle, dogs, pigeons, etc. It is true that all the efforts of breeders have not raised from wild horses anything but horses, from the wild rock-pigeons anything but pigeons. But they have experimented only on species in which specialisation had already gone very far, and in which, consequently, the range of variation was narrow,[1] so that we should rather wonder at the greatness of their success than at their comparative failure. Moreover the time available has been short. Palæolithic man, as far as is known, had no domestic animals. Most of those we have now were domesticated in the neolithic period, probably less than a million years ago. And during the greater part of this time there was, of course, a great want of thoroughness and system about the breeders' methods. Within this century many new breeds have been developed and we cannot but wonder at the great triumphs of the short period during which science and system have been brought to bear. Nature, the great experimenter, took in hand at the outset unspecialised and, therefore, more plastic forms and has continued her experiments for millions of years. It is often maintained that man has not produced results in any way similar to those we attribute to Natural Selection since all his new breeds of pigeons, for instance, are fertile *inter se* and are, therefore, mere varieties,

[1] See pp. 137-147.

not species. But it is probable that this test would condemn a great many wild species which are kept apart from others by the clannishness of their members, not by intersterility.

Artificial selection as practised by the breeder is not in any way different in kind from Natural Selection. Unfortunately the absolutely conclusive experiment, the development of a complex animal from a one-celled organism, is altogether beyond man's power. Natural Selection, therefore, remains a reasonable hypothesis that can never be proved, but which commends itself to a majority of competent judges. Among those who support it, however, are some who while holding that it can account for a great many of the phenomena of the animal and vegetable kingdoms, yet deny that it can account for all.

Before ending this section I will point out how curious has been the evolution of opinion on the subject of evolution. Before the publication of Darwin's *Origin of Species*, the theory of evolution was much discussed but was generally rejected by naturalists as it could not be shown what had brought it about. Darwin's Natural Selection was welcomed as the working principle which had made it possible. Darwinism, therefore, led men to believe in evolution. A majority, probably a considerable majority of naturalists, are still Darwinians, but there are now not a few who, while accepting evolution, are half inclined to reject Darwinism, to scoff at the bridge by which the scientific world made its way to evolution over a sea of difficulties.

II

THE EARLY STAGES OF EVOLUTION

All living things are made up of minute cells and the simplest that are known consist of one cell only. Among the unicellular organisms I select for description one which, though not by any means the least specialised, is yet low enough in the scale to give some idea of the lowest forms of life, and at the same time has the advantage of being easily obtainable. The Unicellular organisms

organism in question is found on dead leaves or other things in stagnant water, and is called the amœba, *i.e.* the changeable, the Protean.[1] It can hardly be seen without the aid of a microscope since its diameter is not more than $\frac{1}{100}$ of an inch. To search for it, a low power is best: when it has been found, a higher power (a $\frac{1}{4}$ or $\frac{1}{8}$ inch glass) should be used.

The amœba is excellently described in Parker's *Lessons in Elementary Biology* where justice is done to every trait in its character. It is a little blob of jelly, or, to use the scientific term, protoplasm. The greater part of its extent is greyish and granulated, but surrounding this is a narrow margin of transparent material. If the amœba is active, as according to its name it should be, it will be seen soon to extend a tongue of its transparent substance in one direction or another, and then the granulated grey will begin to stream into the protruded transparent tongue. As you watch its movements it seems like an uncanny piece of inorganic matter moved by some power not its own, rather than a living being. At times in its life come periods of torpor. Possibly because the conditions are adverse, or for other reasons unknown, it will form round itself a chitinous case or cyst similar in composition to the shell of the lobster.

The constituents of the protoplasm of which the amœba is composed are mainly those that make up the substances known as proteids—viz., carbon, oxygen, nitrogen, hydrogen, sulphur. The carbon forms more than 50 per cent. of the whole, and I have arranged them all in order according to the amount which they contribute. These with a good deal of water and some mineral matter compose protoplasm, and protoplasm is the essential constituent of all organisms whether animal or vegetable.

An amœba has no strong cell-wall surrounding it; and as it flows about, if it comes in contact with anything edible (such as a diatom, a minute vegetable with a flinty covering), its protoplasm closes round it, and the diatom is, to use the correct term,

[1] Should the reader search in vain for Amœbæ, he may for one shilling obtain a number in a tube from Mr Bolton, 25 Balsall Heath Road, Birmingham.

ingested. The amœba, therefore, has rudimentary senses, though no sense organs, for it discriminates between objects with which it comes in contact, and selects what it will swallow. You may have to watch long if you wish to hit upon the moment of capture and absorption, but diatoms are very frequently visible in the body of an amœba. There all the protoplasm they contain is dissolved and assimilated, after which the flinty envelope is got rid of. Proteids, and nothing but proteids, are the amœba's food, and proteids are equivalent to protoplasm. Hence it feeds on living organisms only; inorganic matter is no nourishment for it. The processes of eating, assimilating and ejecting that I have described, it is able to carry on without any special organ. But if an amœba be examined carefully, a round transparent space may often be seen in the greyish substance. This is what is called the contractile vacuole; it contracts periodically and suddenly disappears, then slowly reappears. The object of this seems to be the excretion of waste matters in a fluid form, though this work is performed also by the whole surface. The contractile vacuole is the first step towards the formation of special organs for the performance of the functions of life.

It is well now to stain the amœba with carmine or a very weak solution of iodine. The animal will be killed by this, and then there will be seen in its inner untransparent part a roundish spot called the nucleus, which is the central citadel of its life. When the cell structure of living organisms was first discovered, the cell itself was thought to have no architecture of its own. It was a structureless unit. Then the nucleus was discovered, and in many cases a nucleolus [1] within the nucleus. Now the nucleus itself is found to have a complicated organisation, and to be capable of undergoing changes, the meaning of which can only be guessed. The description of these I must put off for the present.

We must now investigate the amœba's method of reproduction. It multiplies by a process called fission. The cell divides, the nucleus being in every case halved, and there are two amœbæ instead of one. But after a long series of fissions all the indi-

[1] This is not the same as the micro-nucleus mentioned below.

viduals thus produced are weak and senile—I infer this from what has been proved in the case of other unicellular organisms. Vigorous life and continued fission are no longer possible to the amœba except on one condition: it must fuse or conjugate with another amœba, and then rejuvenescence will follow.[1] The interchange of matter between the two nuclei is a lengthy process, during which many generations might have been born by fission. It seems, therefore, *a priori* probable that conjugation intervenes, because without it further multiplication is impossible. But there is direct evidence. M. Maupas succeeded in isolating individual infusorians (one-celled animals moving by means of small hair-like structures called cilia): a single representative of a species was set apart, and the number of fissions which took place were counted. In some cases they amounted to as many as 600. But in every instance there came at length a time when the organisms were unable to continue reproducing themselves by this means; they encysted or died of atrophy, being no longer able to nourish themselves. But if, when the power of fission was coming to an end, one was removed from the rest and put with one of another stock, conjugation took place. The two individuals united, and there was an interchange of nuclear matter, which *is the essential part of the process. This is effected by that part of the nucleus which is called the micro-nucleus and which* couples with the corresponding part in the other individual. After the interchange the two infusorians separate, and after some interval fission begins again. That conjugation brings about rejuvenescence, there is every reason to believe. The reduction in the size of the micro-nucleus when the power of fission comes to an end seems to be a sign of senility. In some cases even external characters (among them the mouth, the most important of them all) was found to be very imperfectly developed.

It may possibly be objected that the conditions were unnatural, the specimens being kept in a small amount of water under glass. But they were carefully supplied with their proper food, animal in some cases, vegetable in others, and seem to have enjoyed

[1] Some authorities deny that conjugation takes place among amœbæ. See p. 34.

perfect health. Sometimes they were purposely starved, and this hastened the time when conjugation became necessary, if they were to survive. But in either case—whether decrepitude was due to excess of fission or to unhealthy conditions—conjugation brought renewed vitality, unless, as it did in some cases of extreme exhaustion, it took place between members of the same stock, descendants of the same individual.

This is a very brief account of very ingenious and long-continued experiments that are fully and clearly described by M. Maupas himself.[1] It is impossible not to admire the cleverness of the methods by which he keeps his specimens under observation. And difficult as it must have been, even with the best of methods, to count the hundreds that sprang from a single isolated individual, yet he seems to have succeeded. His totals are not far out, though of course not absolutely accurate. His patience is no less conspicuous than his ingenuity. By repeated experiments on many species he accumulates evidence that puts his theory of rejuvenescence by conjugation on a firm basis.

Thus much on the subject of the Amœba and the Infusorians. Lower in the scale come the bacteria or microbes, the best known form of which is shaped like a rod pinched in the middle, and having a flagellum at either end. The bacteria, so far as is known, *multiply by an endless series of fissions; conjugation never intervenes to break the interminable succession. In the lowest of the one-celled organisms no structure or organisation has been discovered*; no nucleus is visible. But it would be wrong to assume that none exists, simply because it cannot be seen. For in the cell from which a horse, for instance, is to grow there must be an elaborate organisation representing the animal that is to develop from it, but the eye, aided by the most powerful microscope, can detect nothing of it.

From Protozoa to Metazoa

The infusorian, as we have seen, multiplies by fission for a number of generations, after which senility sets in, and with conjugation comes a rejuvenescence. Now if, when a cell

[1] See M. Maupas' two papers in the *Archives de Zoologie expérimentale et générale: La multiplication des infusoires ciliés*, 1888, and *Le Rajeunissement Karyogamique chez les ciliés*, 1889.

divided into two, these two, instead of swimming off, each as a separate individual, remained attached, then there would be a two-celled animal. If this were continued further we should have an animal composed of many cells—in fact one of the Metazoa. If they adhered together in a rounded mass there would be an organism very similar to the Morula (see p. 16), that occurs as one of the phases through which the embryo of any of the higher animals passes. Supposing that differentiation of cells arose, those on the outside, for instance, undertaking different functions from those in the interior, there would be another step onward in evolution. To this complex animal, whose life depends on an unceasing process of cell-proliferation, there might come a time of senility no less than to its one-celled ancestor. And rejuvenescence might be possible only by a process similar to the conjugation which gave to the ancestor fresh life. But the cell which united with another cell, belonging to another complex animal, would no longer be itself the whole organism, but only one small part to which the duty of reproduction was assigned, this small part a microcosm, in which must lie dormant all the properties of the individual to which it belongs, since from it a similar individual must spring. Thus *there would be no rejuvenescence of the whole organism, but only of the cell set apart, which would thus, in its turn, be able to develop into a complex animal. In fact, the repeated fissions of the amœba correspond to the repeated cell-divisions by means* of which a human being, for instance, grows: the myriads of cells thus formed hold together and build up one organism, instead of breaking away as independent individuals.[1] Sexual union corresponds to the conjugation of the amœba. But its vitalising effect does not extend to the marvellously complex organism of which the uniting cell has been a part. The vigour, due to the union, goes to the formation of another highly organised individual closely resembling those to which the uniting cells belonged.

Among insects (aphides, for example) we find the curious phenomenon of parthenogenesis, reproduction in which the male takes no part, but though this may continue for many generations

[1] Mr Archdall Reid (*Present Evolution of Man*) explains this clearly.

there is no reason to suppose that it can go on indefinitely. After a time there is a return to sexual generation.

We have now seen the first great step in evolution: the cells, when they divide adhere together and specialise, the result being a complex organism. Germ-plasm to continue the race, is set apart in the reproductive cells. The eventual death of the organism follows as a necessity from the division of labour.

III

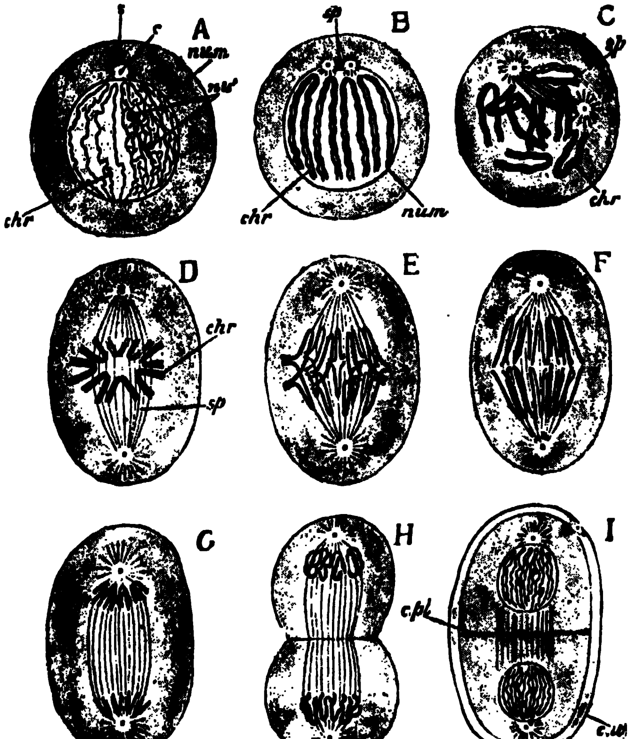
THE DEVELOPMENT OF THE INDIVIDUAL

The ontogeny recapitulates briefly the phylogeny. The development of the individual gives a brief resumé of the history of the evolution of the species. Unfortunately it is not only brief, but somewhat confused: there are great blanks in the story and there are later insertions. Much as we may regret this, it is only what was to be expected. The phylogeny runs its course in the open world amid dangers and hardships: whereas the embryo of the bird undergoes most of its development within the egg, and that of the higher mammals in the body of the mother. Hence we find membranes developed which could not form part of any mature animal roughing *it in the world: in the chick two of them are netted with blood vessels by means of which it breathes the air that finds its way through the shell of the egg. In the higher or placental mammals three membranes combine to form a* connection with the wall of the uterus and by means of this connection, called the placenta, the embryo is nourished by the blood of the mother. Then, too, in the avian egg and that of the ornithorhyncus, the lowest of mammals, much has been added to the minimum that constitutes an egg; they have departed from primitive simplicity. The distant marine ancestors of mammals scattered their tiny eggs in the water. Then came a great development of yolk for food and the membranes already mentioned, then the reduction of the egg to quite a small size.

In spite of all these causes of obscurity, the brief recapitulation tells us a great deal. I will select a few striking points, such

only as are required to make clear what I have to say about evolution.

The egg before it is fertilised, of course, like other cells, contains a nucleus, and in the process of maturation this under-



1.—Diagrams illustrating karyokinesis. A, the resting cell; B, C, D, succes- hases in the formation and the arrangement of the chromatin loops and of the nuclear spindle; E, F, G, separation of the two sets of daughter chromosomes and their passage towards the poles of the spindle; H, I, division of the cell body and formation of the two new nuclei; *c*, centrosome; *chr*, chromatin; *cpl*, cell plate; *nu*, nucleol.; *num*, nuclear membrane; *s*, astrosphere; *sp*, spindle. (From Parker's *Biology*, after Fleming, Rabl, etc.).

goes elaborate changes. The nucleus divides twice. Now, there are two kinds of cell-dividing, one simple in which the nucleus merely separates into two equal parts, the other extremely complicated. This complicated method bears the

name of Karyokinesis. The accompanying figures will show how entangled the process is. There is no need, however, to follow it out in detail, but only to emphasise one or two points. First, the important part is not played, it is believed, by the small star-like body called the astrosphere which appears near the nucleus, but by the nucleus itself and not by the whole of it, but by certain loops of protoplasm which it contains and which take up colour very readily, for which reason they are called the chromosomes. In the course of the process each loop splits along its entire length, so that the four in fig. B have become eight in fig. C. Under ordinary circumstances at the end of the nuclear division there would be two cells, but in the case of the egg, this is not so: one of the resulting

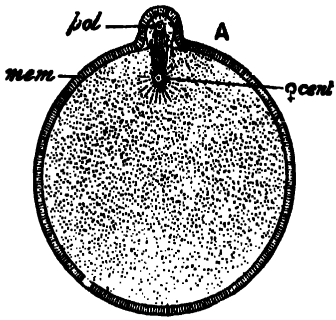


FIG. 2.—Diagram illustrating the maturation of the ovum. The first polar globule is forming. *Mem*, egg membrane; *pol*, polar body; *cent*, centrosome. (From Parker and Haswell's *Zoology*.)

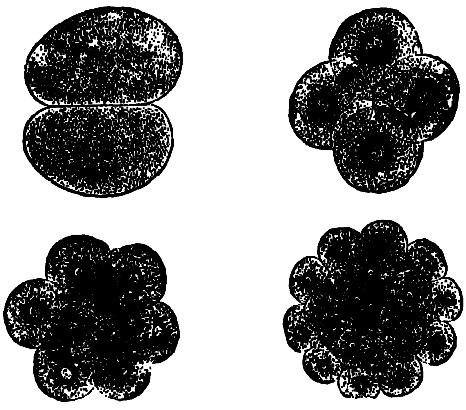


FIG. 3.—Various stages in the segmentation of the ovum. (From Parker and Haswell after Gegenbaur).

halves of the nucleus shrivels into a round particle, called the polar body, and is ejected (fig. 2). The process of division

is repeated again and another polar body passes out. The egg is now ready for fertilisation, and, when this has taken place, development goes rapidly forward. It first divides

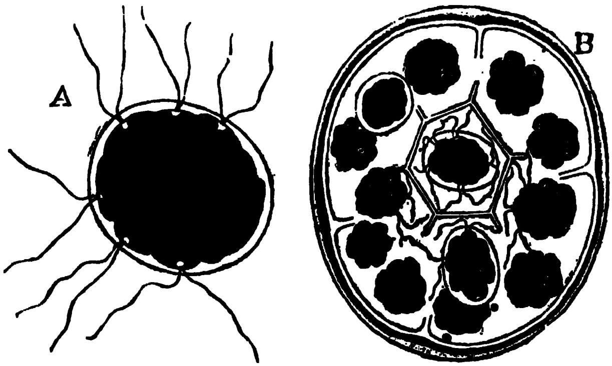


FIG. 4 A.—*Pandorina Morum*—A, entire colony; B, asexual reproduction, each zooid dividing into a daughter colony. (From T. J. Parker after Goebel.)

into two similar cells, then each of these again divides. When a number of cells are thus formed it is called a morula from its resemblance to a mulberry (fig. 3) a stage found in the ontogeny of the sponge and all animals above it in rank.

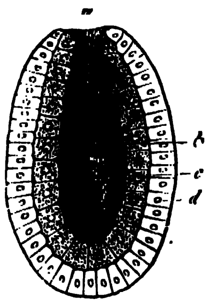


FIG. 5.—Gastrula in longitudinal section. *a*, mouth; *b*, enteron; *c*, endoderm; *d*, ectoderm. (From Parker and Haswell, after Gegenbaur.)

In this stage it is very similar to Pandorina, a creature found in pond-water. In the illustration Pandorina is seen to consist of a colony of sixteen one-celled animals enclosed in a thin membrane. In B each of the sixteen is dividing into sixteen. When the envelope breaks there will be sixteen daughter colonies. The next important stage is the gastrula where the primitive digestive cavity is seen. For sea anemones and fresh water hydras this is not a passing phase, but the final goal of their development. They are bags with double walls, gastrulas in fact, with a number of

adaptations to their special circumstances and mode of life.

The gastrula stage past, all the members of the vertebrate group are still running parallel to one another. In fig. 6 is seen the primitive streak that marks the line where the backbone is to form. In both birds and mammals gill arches appear, showing that their ancestors

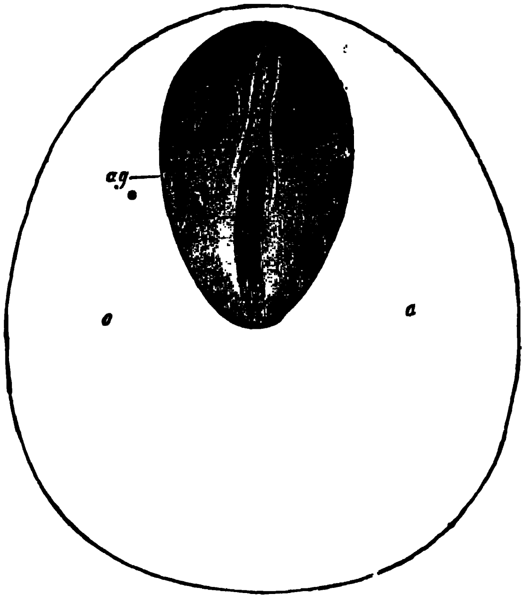


FIG. 6.—Embryonic area of a seven days' embryo rabbit. *ag*, embryonic area ; *o*, place of future vascular area ; *pr*, primitive streak ; *rf*, medullary grove. (From Parker and Haswell after Balfour after Kölliker.)

were once "water-breathers," though the arches have ceased to bear functional gills (fig. 7). In both, the heart, that is eventually to be divided into four chambers, begins as a simple tube, but here the record is obscure, and it cannot be said that it is at any period definitely the two-chambered heart of a fish or the three-chambered heart of a reptile.

This very fragmentary sketch of the parallel development of

various classes of animals is intended to serve two purposes, first to show that embryologists have discovered facts for which only the theory of evolution can account, and secondly to make some of my subsequent chapters easily intelligible to the general reader.

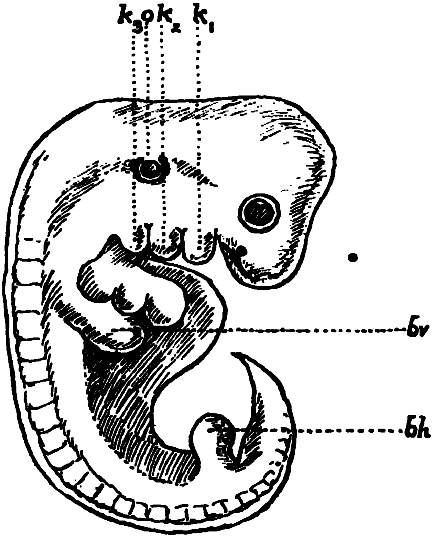


FIG. 7.—Human embryo. (After Haeckel.) *o*, ear; *k*3, *k*2, *k*1, gill arches; *bv*, fore limb; *bh*, hind limb.

Chapter II

HEREDITY, VARIATION AND DEATH

Heredity is so familiar a thing that we have ceased to wonder at it. It is a matter of course that children should be like their parents, that an acorn should grow into an oak, an orange pip into an orange tree. But whenever men have reflected seriously on the matter, it has filled them with astonishment. The old theory was that the acorn contained a tiny oak tree which "unfolded" and so became a giant of the forest; and not only that, but within the tiny embryo tree was another tiny embryo and within that another. If it was not so, where did the oak come from? The reasoning was perfectly sound, but when good microscopes were obtainable, men looked for the oak tree and it was not to be found.

The ancient theory

No actual oak tree is there, yet a potential oak there is. Plant an acorn and it will be proved. In the same way the chicken must be potentially in the egg before incubation has taken place though no chicken is to be seen. And here another question arises: an egg is the mother of the hen, but is a hen the mother of the eggs she lays? Professor Weismann says "certainly not" and the world is coming to agree with him. The egg and the hen that lays it are both sprung from the same egg. In the line of descent egg follows egg; each, if it hatches, becomes the mother of a chick and, if the chick be a hen bird, of other eggs also that may in time be laid and duly sat upon and hatched. This is the theory that Professor Weismann has spent years in maintaining, and since the inferences that may be drawn from it are of the utmost importance, I shall try to state his views as clearly as I can.

Brief statement of Weismann's views

"The nucleus of the reproductive cell bears all the hereditary characters; and it is almost certain that it is not the whole nucleus but the *loops of chromatin that have this function:*

observation shows that they are the essential part, the astrosphere merely supplying motive power.

"The illustrations on page 14 will make what follows easier to understand.

"When the egg is maturing we see that the nucleus is divided by an elaborate process, and one resultant half, the first polar body, is expelled from the cell. After this there follows a repetition of the process, and a second polar body is thrust out. The former of these divisions has for its object the rearrangement of the particles that make up the germ-plasm, that part of the nucleus by which heredity is maintained, and which is formed of the various chromatin loops.[1] The second division reduces the amount of plasm and reduces the number of hereditary characters to one-half. This reduction must take place, since the egg is to be fertilised without any increase in the number of the essential particles. When parthenogenesis (birth from unfertilised eggs) takes place, for instance, in aphides and bees, only one polar body is got rid of: the division of the nucleus that results in this is a rearrangement of material with a view to variation, since without variation there would be no evolution. No second polar body is extruded, since whenever parthenogenesis is to take place there is no need to reduce the plasm to half its amount. It has been held that the ejection of the second polar body leaves the egg female in character, whereas formerly it had contained the elements of both sexes. The fact that male traits are often handed down through the female, and *vice versâ*, disproves this idea. It is true that the egg has sexual characteristics (such as food for the embryo), but the germ-plasm has none. Sex is a secondary character in the offspring. Experiments on tadpoles, caterpillars and rotifers have shown that food and temperature are factors in determining it.[2]

"If the egg is the scene of two nuclear divisions, one leading

[1] On this see Maupas: *Archives de Zoologie expér. et générale*, vol. vii. p. 397 (1889).

[2] In the case of tadpoles further evidence is needed to substantiate this.

to modifications in the arrangement of characters, the other to a reduction in the amount of the plasm, similar phenomena ought to be observable in the maturation of the male or sperm-cell. This has been shown to be true of the sperm-cells of ascaris (a nematode worm); there are two cell-divisions: as in the egg, the amount of the chromatin is reduced by one-half, and here too the germ-plasm is non-sexual: the sexual characteristics of the cell are secondary.

"Each of the two cells that are to fuse is made up of very minute vital particles called biophors; these combine together to form determinants, each representing a bodily characteristic, and *these determinants are grouped into ids. The cell not only contains thousands of determinants or characters—each part of the body that has a character of its own must have its own determinant—but it must have, besides that, a definite architecture.* Each of the combining cells has a very similar, but not the same, architecture, and the object of the fusing of the two is to produce variations without which we should not be able to account for the evolution of different species. It is certainly not a vitalising process, producing rejuvenescence, for it has been shown that in the unicellular organisms, the corresponding process, conjugation, very much delays reproduction by fission. Parthenogenesis proves that an egg, without fertilisation, is capable of reproduction.

"But Natural Selection could not go on without variations, and in conjugation and sexual union is the chief source from which variations arise. In unicellular organisms, it is true, variations are largely due to external conditions. But this cause is of quite minor importance among the metazoa, for in them the reproductive cells are isolated, and it is important to remember that the environment can only affect the germ-cells by acting *directly* upon them. In parthenogenetic eggs, if we neglect the insignificant influence of external conditions, the preliminary division of the nucleus is the only source of variations, and it is found that animals born from such eggs do vary. But far less diversity is likely to result in this way. Hence conjugation and sexual union have arisen; they supply to

Natural Selection the variations which it requires as its raw material: the production of variations is their sole *raison d'être.*

"In the diptera (among them our common flies) certain cells, containing unaltered germ-plasm, are from the first set apart. In other cases the separation takes place later in the course of development, in the hydra even after the formation of a fresh person or individual (neither term is satisfactory) by budding. Nevertheless, it *is* a part of the original germ-plasm. A sharp distinction must be drawn between the germ-cells and the *soma*: between the cells whose function is reproductive, and all the others of which the individual is composed. From a fertilised germ-cell a new individual springs: in this individual, germ-plasm is set apart unaltered, and so the race is continued. From the *isolation of the germ-cells, it follows that only by a process very difficult to imagine can characteristics acquired by the soma be transferred to them. All variations originate in the germ-plasm.*

"The idea that death is an attribute of life, that it is the nature of living things to die, has led to much error. Conjugation, owing to this assumption, has been considered to be a vitalising process, and the experiments of M. Maupas on Infusorians might seem to prove it.[1] They only prove that in certain species reproduction follows a cyclic method, taking place now by fission, now by conjugation, the latter process intervening occasionally to produce variations for Natural Selection to work upon. In Cypris, the water flea, parthenogenesis may, as experiment has shown, continue practically for ever.[2] Death is the result of Natural Selection; the species that were cumbered with aged or out-of-date individuals were at a disadvantage and disappeared. Sexual reproduction is not a means of restoring lost vigour but of producing variations. Favourable variations would obviously be of advantage to the species. Those individuals that multiplied by fission only, though potentially immortal, disappeared in the struggle for existence, because the

[1] See p. 10.

[2] Forty parthogenetic generations of *Cypris reptans* were observed by Weismann. See *Essays*, vo.l ii. p. 198.

resultant cells, when they divided, showed fewer variations and so were not so well constituted for the establishment of new species."

After having thus rounded off his hypothesis and maintained it in the teeth of all objectors, Weismann proceeded in his book *The Germ Plasm, a Theory of Heredity* to modify his theory of the significance of amphimixis, a term which includes conjugation and sexual union. It ceased suddenly to be the prime cause of variation. "The cause must lie deeper than this, it must be due to the direct action of external conditions on the biophors and determinants" (in the reproduction cells, not in the soma).[1]

He had already recognised such direct external influences as a minor cause of change.[2] But amphimixis had always ranked as first in importance. Now it seems suddenly condemned to play second fiddle; it only combines variations, it does not originate them.[3]

Why this sudden change? It was due, no doubt, to a breakdown of the elaborate architecture of the germ-plasm — the biophors, determinants, ids, idants. A highly complex animal must have more determinants than a less complex one, and Weismann could not see how amphimixis alone could ever cause a multiplication of them.[4] The whole difficulty has its origin in the attempt to explain the inexplicable architecture of the germ-plasm. Surely it would have been enough to say that it is somehow there, whether we can picture it to ourselves or not. As to variations, we know that crossing does produce them and, since no two individuals are exactly alike, every union is of the nature of a cross. This being so, I cannot help regarding Weismann's earlier views upon the significance of amphimixis as worthier of him than this later phase.

I believe I have stated Weismann's views fairly, and, I hope, clearly. They contain strange paradoxes that have excited ridicule; some of them will, I believe, always excite amusement and it must be owned that his shifts, refinements and modifications, his endless manufacture and elaboration of hypo- Estimate of Weismann's theory

[1] See *Germ Plasm*, p. 415.
[2] See *Essay upon Heredity*, vol. i. p. 420.
[3] *Germ Plasm*, p. 431.
[4] *Loc. cit.* p. 415.

theses and supplementary hypotheses must be reckoned among the most serious ills that a biologist at the present day is heir to. Moreover, he seems sometimes through carelessness of expression to deify Natural Selection and endow it with creative power. But careful reading of his essays will remove this first impression, though, short of actually creating, he assumes that it can do anything and everything.

What solid result is there? That is the important question. *An impartial critic must own, that from all Weismann's theorising there emerges one great idea of the utmost value as a basis for a theory of heredity — the continuity of the germ-plasm.* This doctrine once established, the non-inheritance of the modifications of the soma due to exercise or external conditions, though not a logical deduction from it, yet becomes a probability. Round the question of heredity there still rages a turmoil of angry controversy, but, though the clamour does not diminish, there is less divergence of view. The rival theories tend to approximate to Weismann's and, in spite of all the strife and hurly-burly, the continuity of the germ-plasm holds the field.

The theory rests on a firm foundation. We know that the nucleus of the germ cells contain closely packed, all the characters of the animal that is to grow from them. If part of the germ-plasm remains undisintegrated, its architecture unshattered; if the germ cells are separated off from the rest of the body (from the soma) except in so far as they receive nourishment from it; if in their seclusion they continue to multiply by fission, each resultant half containing the same characters, all else in their life being merely the assimilation of food—then we can understand how parental and distant ancestral traits can be transmitted. But if the particles that represent characters were scattered all over the body, how could they be re-collected and replaced each in its proper position? Such a thing would puzzle the wildest imagination. We are driven, then, to conclude that germ-plasm is kept unaltered and that from it springs the next generation.

Besides this we have a parallel among the Protozoa. They

multiply by fission: and we can understand why each is like all, for they are all parts of the same. If we adopt the theory of the continuity of the germ-plasm then we account for the likeness of father and son on the same principle as we account for the likeness of one amœba to another.

Lastly, there is some direct evidence. In the Diptera,[1] as different observers have discovered independently, the reproductive cells arise directly from the parent egg cell and are set apart from the first. Here, there is proved continuity. *In leeches and some arthropods they are set apart very early.*

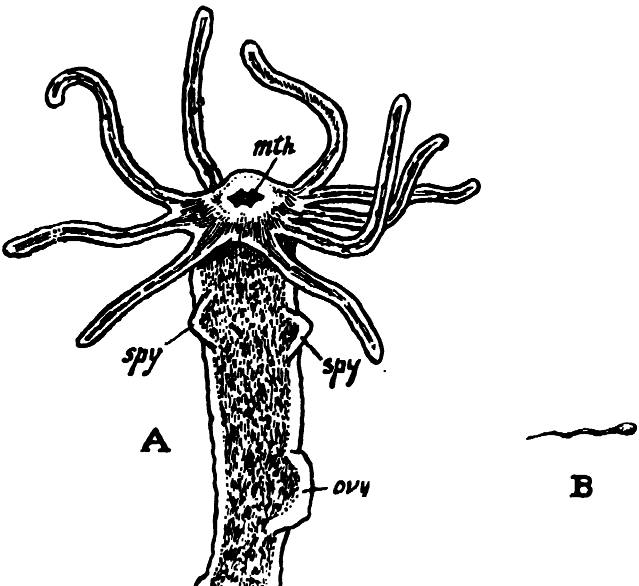


FIG. 8.—A, Hydra; B, Sperm or male cell of hydra; *mth*, mouth; *spy*, two spermaries; *ovy*, an ovary. From Parker's Biology.

In other classes the separation is put off for some days or weeks and this is, no doubt, a difficulty. But, I believe the difficulty is slight. In these we may hold that at least some of the body cells are up to this time potentially reproductive

[1] See Weismann: *Essays on Heredity*, vol. i. p. 200.

cells; they contain germ-plasm unaltered, though they have not the secondary characteristic of sex. The hydra, the remarkable small creatures so often found clinging to duckweed, brings this difficulty to a head.

It habitually propagates by buds, and these buds break off and grow into independent hydras in which both male and female reproductive cells are developed; the former assume a tadpole form and swim to the egg cells. This shows clearly that the germ-plasm is not isolated from the first. Weismann has, however, proved that it is only from the ectoderm or outer layer of the body that the reproductive cells are formed. Hence, even in the hydra, there is some localisation. Dropping Weismann's elaborate architectural terms — ids, determinants, biophors—I think the facts may be provisionally explained thus. *The germ-plasm within the germ cells remains absolutely unspecialised, it contains all the elements of which the body is formed. But in some parts of the body there* is less specialisation than in others; in the hydra and other low organisms some of the body cells are (except for secondary characters without which sexual generation would be impossible) reproductive cells. In the higher animals specialisation has gone much further and we may hold that in them there is a complete localisation of the germ-plasm. As Mr Galton has put it, "The main line may be rudely likened to the chain of a necklace and the personalities to pendants attached to its links."[1] The same thing has been expressed in legal phraseology: the relation of a parent to his child is that of trustee rather than of testator. Thus we return to what was said above: the hen is not the mother of the egg, but the egg is the mother of the hen and of other eggs which may in due course develop into chickens.

Darwin's Pangenesis

If we throw over the continuity of the germ-plasm, what are the alternatives? One is to adopt some such theory as Darwin's Pangenesis according to which the various parts of the body throw off innumerable minute particles, called by him

[1] *Natural Inheritance*, p. 19.

gemmules, which somehow find their way to the reproductive cells. And thus the germ-plasm is formed in part, and might, by a slight extension of the theory, be formed wholly from the body. The hypothesis, thus extended, would give us alternating generations of persons and reproductive cells. This theory of Darwin's was only intended to be provisional—a means of accounting for the supposed inheritance of acquired characteristics—and there are insurmountable objections to it. How can these gemmules find their way to their destination? How are they worked into the organisation of the germ-plasm? And would they not be assimilated like other matter ingested?

There is, besides, the theory of epigenesis, the supporters of which maintain that Weismann's preformation, the idea that one cell can contain potentially the whole future animal, is absurd. *According to them the embryo is shaped by external influences: the cells get their characters from their position relatively to one another, from the temperature, food and all that is summed up in* environment. And so the thorough-going advocates of epigenesis, if such there be, would have us believe in the differentiation of identical embryos into a host of different species! When we remember what minute differences are hereditary, environment is a wretched reed to lean upon. Weismann speaks of a family known to him in which a small depression no bigger than a pin's head appears in the skin in front of the left ear in each generation. And this small depression must somehow be represented in the germ-plasm. No environment can cause it. Epigenesis

The attempt to formulate the theory of epigenesis has given strength to the theory of the continuity of the germ-plasm. I recommend anyone who is unconvinced to read Hertwig's *Biological Problem of To-Day*. It is an attempt to overthrow Weismannism and put epigenesis in its place. The destructive part of the book raises some formidable difficulties as one might expect. But in the constructive part there is an almost complete surrender of the position. After an elaborate attempt to show that the environment guides the development of the embryo, comes the confession that each animal has its characteristic germ-plasm and that the environment alone cannot decide

character. The only questions that remain, then, are: how far is the germ-plasm localised? How far is it present, in a dormant state, in the body cells generally? In other words,—how far has specialisation gone on? To what extent have the cells of the soma lost their power of building up a complete individual? These after all are questions of detail. They do not touch the question of absolute continuity.

Reproduction of lost parts

Some of the chief difficulties that Hertwig mentions will show this. Nais, one of the loosely defined group of worms, has an extraordinary power of regenerating lost parts. If it be cut in half, the anterior end reproduces the posterior: the posterior end reproduces the anterior. It is commonly supposed that the same phenomenon occurs with earth-worms, and that you can make one into two. This, however, is not the case. The front end will reproduce the hinder end, but the more wonderful phenomenon of the reproduction of the chief body organs from the posterior end does not show itself. However, in Nais it is an undoubted fact. There are many other less striking instances of regeneration. If a crayfish loses a claw, a new one is soon to be seen taking exactly the form of the lost limb. When a lizard loses its tail it grows again. In Tritons and Salamanders the whole limb grows, if it is amputated. In the former even a jaw is replaced. This is an astonishing fact, but it is very different from what happens in Nais. Low down in the animal kingdom we have frequent examples of regeneration. But when we ascend to the higher forms of animal life, such phenomena almost disappear. The following instance is an almost solitary one from a class so high as birds.[1] A stork had the upper part of its beak accidentally broken off, whereupon the lower portion was sawn off at the same point: both parts in time grew again. Certainly when we descend low in the scale, we find such cases more frequent, but we cannot say that the power of regeneration is in inverse proportion to the degree of organisation, for no such power seems to exist in fish which are lower in the scale than Tritons and Salamanders.

Regeneration in the ordinary course of life, not in consequence

[1] See Weismann: *Germ Plasm*, p. 125.

of injuries, is found in higher classes of animals. Stags replace lost horns, and birds at every moult replace lost feathers. If we turn to plants we find the power almost unlimited: a bud is formed and from it grows a shoot that bears flowers—*i.e.* practically a new plant. Besides this, there is a phenomenon which is often spoken of as distinct from the last-mentioned, though really the same. One organ of a plant will produce another organ which is not properly found there. A slip is cut from a willow, and when it is put into the ground it throws out roots. If you look into the hollow of a decaying willow tree you will find the branches sending out roots into the rotten wood, the mortified parts of the tree being food to the living. All these phenomena admit of one explanation, though, to strengthen the case against Weismann and his germ-plasm, they have been carefully classified and distinguished till it has seemed that there are a host of dragons in the path, some one of which must be capable of strangling the unfortunate theory. Weismann's defence, I believe, meets all these attacks, but the technicality of the terms he has used and his elaboration of hypotheses have sometimes produced the impression that weak points have been discovered, and that there has been a complete breakdown. Stripped of all technicalities, I think his answer to these objections amounts to this. In the development of the animal body, after some of the initial stages, in some cases from the very first, specialisation of the germ-plasm takes place. Some elements are sent here, others there, as they are required. *Before development has advanced far some of the somatic or body-cells may contain germ-plasm unaltered. In some of the lower animals, such* as the hydra, this state of things may continue throughout life. Whenever in a hydra reproductive cells are formed, or in a plant flowers containing seed and pollen, secondary sexual characters are added. But cells essentially similar, in that they contain germ-plasm, exist in other parts of the hydra or the plant. Thus, so far as continuity is concerned, Weismann has maintained his position; as to localisation, he has had to make concessions and to modify his theory.

Evolution of Weismann's views

It will be well now to consider the evolution of Weismann's views, for they too have had their stages of development. His essays, as they have appeared in succession, the earliest of the series in 1881, supply us with a very interesting history of the evolution of his theory in an exceedingly critical environment. Every fresh development has come in response to a stimulus from without, some criticism, intended to be fatal, but which has produced merely some readjustment, usually slight, sometimes considerable. The theory has, in fact, adapted itself to the environment of facts.

Weismann saw two very remarkable phenomena for which a theoretical basis must be found. First, heredity, the recognised fact that sons closely resemble their parents; secondly, the fact, as he himself considered it to be, that acquired characteristics are not inherited: *that if the speed of a horse is increased by training, the increase of muscular power, so obtained, is not transmitted.*

These two phenomena he accounted for by his theory: (1) the germ-plasm was continuous; (2) *the cells* which contained it were localised and isolated. The first and great article of his faith he has made good; as to the second, he has had to give way to some extent. *He started with the localisation of the* germ-cells from the very outset in the body. It turned out that in only one case was this literally true; that in some cases they were never completely localised. If their isolation is incomplete, there is a possibility of the modifications of the soma being transferred to them, and the question of the transmission to the next generation of the characters thus acquired, though the continuity of the germ-plasm makes this transmission improbable, must be settled by direct evidence. A variety of cases, where acquired powers seem to reappear in the next generation, must be examined. If no reasonable explanation but that of transmission is possible, then we must assume that it has taken place, even though Weismann has shown how difficult it is to find, between the bodily organ that is modified and the germ-plasm, any channel along which the modifying influence can pass.

The direct evidence, for and against, I shall consider in the next chapter.

To the theory of the continuity of the germ-plasm Weismann has linked another which is really independent of it—his theory of the evolution of death. I restate it for clearness' sake.

Weismann's theory of the evolution of death

"The unicellular organisms are immortal. It is true that they die unless conjugation takes place. But conjugation is part of their normal cyclic life. Death, owing to failure to conjugate, is accidental, not natural. Conjugation is not in its origin a vitalising process. The part assigned to it is the production of variations. Those species in which it was the rule produced more favourable variations than others in which parthenogenesis obtained, and so they have prevailed in the struggle for existence. Conjugation has thus come to be normal, and *Natural Selection has brought it about that all individuals which do not conjugate perish.* They are harmful to the species."

To this account of the origin of death there is an obvious objection. Natural Selection is only a regulating principle. It can create nothing. Natural death exists now, therefore it must have existed from the first. It may, however, have been exceptional and abnormal before animal and vegetable forms attained their present complexity, and through the working of Natural Selection the exceptional may have become normal. Let us take this to be Weismann's meaning. Even though this is conceded, he is still open to the charge of invoking the aid of Natural Selection as a *deus ex machina* whenever he is in difficulties. "Worn out individuals," he says, "are not only valueless to the species, but they are even harmful, for they take the place of those which are sound. Hence, by the operation of Natural Selection, the life of our hypothetically immortal individual would be shortened by the amount which was useless to the species."[1] The individual in question is worn out by accidents, the buffets and shocks of chance, not by disease, for where that exists there must be natural death. In any case, Weismann says, he is *de trop*, and Natural Selection is, therefore, ordered to deprive him of immortality. But Natural Selection will not carry out all and any orders that the scientist may issue, and when she (to resort to personification for a moment) sets to

[1] *Essays upon Heredity*, vol. i. p. 24.

work she chooses the easiest method. The individuals who so cumber the species have already *ex hypothesi* suffered much from accident. Why not another accident to give them the *coup de grace*, instead of waiting for the operation of natural death? Surely the younger and less battered members of the species would be equal to the task. Is not this the method by which sexual selection works? Probably but a small percentage of wild animals die a natural death, though they are all liable to it. The fact is, it is easy to show how Natural Selection can lengthen the normal duration of life, till it is sufficient to allow of the rearing of offspring. But how she can shorten it is not so clear.

Weismann's theory of the origin of death has brought out his combativeness in a most remarkable way. He started with the doctrine of the immortality of the unicellular organisms, showing that those now in existence were but fragments of their primeval ancestors—brothers or sisters would be a more correct term. But when Maupas proved that immortality was dependent on conjugation, the ground seemed to be cut from under a favourite theory. He refuses to budge from his position, but I cannot but think that in doing so he is showing a great power of fight rather than the judgment and reasonableness that science demands.

The view that amphimixis is useful only because it produces variation cannot stand. All characters that are not maintained by Natural Selection tend to disappear. Now species sometimes live in an unchanging environment, so that for hundreds of generations little or no variation is required, and yet no species is known in which amphimixis, having become the rule, has afterwards died out.

After thus criticising Weismann I now proceed to give with some diffidence my own view of the origin of death and of variation. It consists only of ideas that are to be found in Weismann's books, though not all accepted by him, applied in a way that seems to me to explain the known facts. The origin of death is a question of much speculative interest, but it is of far greater importance to realise that varia-

bility is the inevitable result of the process of reproduction and that one great function of Natural Selection is to strengthen heredity and foster faithfulness to type.

A theory of the cause of variations and of death

To find the cause of variations we must study the life of the simplest of known organisms: higher in the scale there is so much complication that it is far more difficult to attain to clear notions. In all the Protozoa we find multiplication by fission: an ultimate fact as far as we can see at present, the cause of which we shall never be able to arrive at. But if fission takes place, it is inevitable that it must at times be imperfect, *i.e.*, that the two cells formed by the division of the nucleus should remain adhering to one another. Thus we have, instead of a one-celled Protozoon, a two-celled Metazoon. Here is an enormous step onward and there is no reason why it should not be often repeated, so that an animal similar to the Morula would be formed. But for further progress variation in the cells themselves is necessary: there must be division of labour. When a cell divides whether simply, or by the elaborate process called Karyokinesis, which has been already described,[1] the two parts appear to be exactly equal. But it is impossible that they can always be exactly equal in size or exactly alike in character. As to size, mathematicians tell us that exact equality is practically unattainable: as to character, the great complication of the organisation makes it impossible for the two resultants to resemble each other in every detail. Hence fission in itself is a source of variation. This Weismann saw and, in one region, turned to account. To explain the advance of evolution beyond the morula stage, in which the cells are all alike, he assumed that after a few cell-divisions in which all the characters were shared by all the resultants, one or more cells must begin dividing unequally the characters or determinants not being the same in the two halves. In this the most thorough-going specialisation and all the complexity of animal organisation have their origin. The soma with all its varied powers is the achievement of the principle of unequal specialising fission: equal fission, the resultant halves being

[1] See p. 14.

exact counterparts one of the other, maintains the conservative reproductive cells. But it can only very rarely happen that the two halves are absolutely exact counterparts, and on this fact, as a foundation, we can build important conclusions. Among bacteria, the only organisms among which, as far as is known, conjugation does not take place, we seem driven to consider this inequality of fission as the sole cause of variation.[1] The environment I cannot look upon as a cause, but merely as a condition to which the organism reacts—a subject for the next chapter. There is amphimixis: if we grant that it may be the primary cause of variation, yet, if the two beings that fuse are identical in character, it must lose much of its efficacy. *If, however, owing to unequal fission a certain amount of differentiation had once arisen, then unions between individuals would lead to an enormous variety of combinations.* Weismann has himself suggested that the first division of the nucleus of the egg of a Metazoon may have for its object a rearrangement of inherited characters. But I do not know that he has applied the same principle to the fission of one-celled organisms. Amphimixis he has declared to be the primary cause of variation. No doubt amphimixis involves a rearrangement of the particles of germ-plasm and so the union of two exactly similar individuals may start variations. But, as is well known, it gains its main efficiency in this respect, from the fact that the two uniting individuals are not exactly similar: every union is more or less of the nature of a cross between two breeds. There is a preliminary dissimilarity, and fission, there is reason to believe, is able to put this at the service of amphimixis, the union of two slightly different cells leading to new combinations and at the same time preventing the complete loss of indispensable characters, one cell supplying the deficiencies of the other. Many evolutionists in discussing the origin of variations make no mention

[1] Mr Adam Sedgwick, F.R.S., in his address to the Zoological Section of the British Association, 1899, said: "Among bacteria alone, so far as I know, has the phenomenon of conjugation never been observed." Some authorities, however, deny it in the case of amœbæ.

of fission, while others reject conjugation as inadequate. The reason of the adverse verdict has, I think, been an incomplete half-hearted acceptance of the principle of evolution. Any of the higher animals you like to choose is so wonderful in its complexity, in the specialisation of its cells—each organ, brain, limbs, heart, blood-vessels, lungs and so forth, all marvellous—that to find the original fountain-head of all this in anything that may happen in the lives of one-celled animals seems to them ridiculous. But an evolutionist is bound to seek for the causes of evolution in the most primitive organisms known to us. And have not the most highly organised animals sprung from the union of two simple cells? Whatever its source, there is reason to believe that the tendency to vary is very strong and is only kept in check by wholesale elimination of individuals that deviate widely from the specific type. Natural Selection maintains and strengthens heredity which, apart from it, would speedily fail and lose its power to guide. It is more difficult to account for the persistence of heredity than for the lapses from it.

It is possible to suggest another cause of variations, but it will be found that I have already mentioned it by implication. There is no life without motion, and motion—certainly this is true of the complicated manœuvres that take place within the nucleus during karyokinesis—can hardly go on without change. Every movement within a cell may cause some trifling rearrangement among particles, some change in the relation of one particle to another. The wonder is, not that alterations should take place, but that the architecture should show such permanence and constancy. It must be understood, then, that when I speak of fission as a cause of variation, I include under the term the movements within the nucleus that in many cases precede fission.

I believe that the infusorian's senility and death after multitudes of fissions is due to excessive specialisation. Weismann himself suggests that the specialisation of the somatic cells *may* be the cause of death in the multicellular animals, the Metazoa, but he rejects it for what seem to me inadequate reasons. In

the Metazoa the specialisation of the somatic cells is a great advantage, while heredity is maintained by the only slightly varying reproductive cells. And we can imagine Natural Selection singling out for survival those organisms in which these two opposite tendencies were developed simultaneously; the conservative cells handing on the characters of the race; the progressive and less stable cells changing in the course of the ontogeny, so as to meet the most varied demands, and then—a wonderful fact!—when once they have gained the requisite qualities, becoming conservative, and maintaining by non-specialising fission the specialities they have developed. In the one-celled animals, as I have shown, there must be the same tendencies. But the tendency to specialise must soon be fatal. An infusorian's one cell must be a Jack of all Trades, or he will be eliminated. When, after multitudes of fissions, therefore, the infusorian grows senile, I believe it is because of failure to divide into similar halves—that is, to specialisation. There is in fact a failure of heredity: some characters are over-represented in one half and under-represented in the other. When *fission has been repeated hundreds of times it is far from wonderful if in every individual thus produced some essential* character is lacking. This becomes all the more probable when we remember that the life histories of the Protozoa and the Metazoa seem to follow parallel lines, a point which, as I have already mentioned,[1] has been well brought out by Mr Archdall Reid.[2] If the cells produced by an amœba's fissions held together there would be formed a Metazoon: the period of fission in the amœba corresponds to the life of the soma of the Metazoa, which life begins with the formation of highly specialised cells. In the Metazoa amphimixis is beyond doubt a return to the non-specialising principle. In the infusorian, then, also, may we not regard conjugation in the same light? Conjugation is the natural corrective of the inevitable tendency of cells to divide unequally. But in the higher animals this specialisation in the soma is an enormous gain. On the other hand, very slight variations are required in the cells set apart

[1] See p. 12. [2] *Present Evolution of Man.*

for reproduction. For though, if the species is to succeed in the struggle with others, slight changes must constantly be originating in them, yet the animals which grow from them must not deviate *widely* from type. One of the higher animals is, therefore, a contrivance resulting from Natural Selection for utilising the two tendencies of cells—to maintain their characters when they divide, but to vary slightly. To put it more correctly, those individuals, in different parts of which these two tendencies were highly developed, have been selected for survival. But even in the somatic cells, in spite of their returning, when once specialised, to the system of equal fission, as far as equality is possible, inevitable specialisation must lead to the same results that we have seen in one-celled creatures: through repeated fissions they will, at last, no longer have that combination of elements on which life depends. So that both in the Protozoa and the Metazoa we may regard fission and over-specialisation as the cause of death: amphimixis and generalisation as the cause of rejuvenescence. But the multicellular are in a very different position from the unicellular. For the Protozoon there is a vitalising process possible, which may restore its youth. *For the Metazoon, as a whole, there is no such magic possibility, but only for special cells set apart for reproduction; for what we think of as the individual, death is inevitable.*

If over-specialisation is the cause of death, and if conjugation exists primarily as an antidote to the destructive tendency, how is it that for bacteria in which fission proceeds, as far as is known, endlessly, uninterrupted by conjugation, there is no natural death? Though I have no wish to shirk answering this question, I must point out that it is quite possible conjugation does go on among bacteria, though no one has yet observed it. Bacteria

But, assuming that it does not, we may certainly hold that for beings that are very little specialised, it is not a necessity. Cell-division may continue for many millions of generations: their living protoplasm may be capable of an eternity of fissions without losing the necessary structural organisation. This view supports the theory which regards death as the result

of over-complexity, over-specialisation. Death, I hold, became normal, inevitable, through this cause. But it must have been present from the first, quite apart from unfavourable conditions, among the simplest of living organisms *as an abnormal occurrence*. There must be natural deaths occasionally among bacteria: among these billions of fissions there must be occasional failures. Does not Darwinism depend upon variations favourable and unfavourable? And an absolute monstrosity even among bacteria will require no helping out of the world. But what at this low level is rare and abnormal, has become normal among the more complex forms of life.

Summary

I have now tried to find the origin of variation and of death. Of both I regard fission as the primary cause. The nucleus cannot in any case be divided into absolutely equal or similar parts, and, besides this, the antecedent movements involve change; hence variation. But this inequality may be so great that one of the resultant "halves" may lack some of the vital elements altogether. In this case death must ensue. Conjugation makes good what is lost and so is the corrective of excessive variability, over-specialisation, loss of vital elements, leading inevitably to death. But since the two uniting organisms are not exactly similar, it must besides restoring vitality lead to new combinations, in fact to variations.

The strength of heredity is the wonderful phenomenon for which we have to account; variability results as a matter of course from the system of reproduction. Heredity can be explained only on the theory of the continuity of the germ-plasm; it owes its strength to the unintermitted action of Natural Selection which is continually checking wild deviations from specific type. And, having been thus developed, it is liable to fail when selection slackens.

Some general reflections on evolution

It is worth while now to pause and reflect how much, or how little, theories of evolution attempt to explain. They are all more or less mechanical theories of life, that undertake to tell us how the development of the complex forms from the simple came about. We have convincing evidence put before us that evolution has taken place and Darwinism supplies us with a good

working hypothesis to account for it. But this fact which I have already emphasised must be borne in mind, viz., that this working hypothesis only provides us with a regulating principle. Granting life as a fact and granting a tendency in living things to vary, there are conditions that confine the flood of life within definite channels and which have made the organic world what it is. All this is of the very greatest interest, but it still leaves life itself a mystery beyond our comprehension. It merely pushes the mystery further and further back. Thus, it is not now the colours of the butterfly, the legs of the antelope or the brain of man, that most excite our wonder. It is the single minute cell from which every individual, however complex, has grown; it is the one-celled organism from which all the higher forms of life have been evolved. In the lowest known organisms in which not even a nucleus can be seen is found potentially all that makes the world varied and beautiful. In beings a little higher in the scale the microscope has revealed an organisation. It has shown us chromosomes or loops of chromatin which go through astonishing kaleidoscopic changes and redistributions. But if the germ-plasm within the nucleus is really the microcosm it is believed to be and must be, there is an organisation altogether indiscernible under the most powerful microscope. These chromatin loops must be made up of particles, each of which has a character of its own, and each its proper place. Hence Weismann's attempt to explain the architecture of the cell and all his array of determinants and biophors. He has not introduced the complication, but has tried to picture it. The complicated arrangement of particles is there, an organisation so perfect that the organisation of the German army compared with it is but blunder and chaos. Yet Weismann's gallant attempt to organise his army of innumerable biophors has often brought ridicule upon his head. However, even if he fails, they organise themselves without his help. *À propos* of this we may recall the old story of Galileo. When compelled to abjure his belief that the earth went round the sun, he is said to have remarked, "But it does for all that." Though he said it *sotto voce*, let us hope the Pope heard it. So Weismann, if he is ever driven (an extremely

improbable hypothesis) to confess that he has failed to marshal his determinants, may say, "After all they can marshal themselves without my drilling them."

Metaphors are always misleading. When we try to describe the cell, the term architecture is unsatisfactory, because fixity is the character of a building. The architecture of the germ-cell takes a peculiar form only to metamorphose itself into another. The changes suggest nothing so much as crystallisation. But whereas each substance that crystallises—water, quartz or whatever it be—forms its proper number of facets and there rests, the nucleus goes through a whole series of changes, even if we take into account only those which can actually be seen. The nucleus is, in fact, a substance which crystallises repeatedly, each form following its predecessor in regular sequence. Equally suggestive of crystallisation is the growth of a complex animal from a single cell; at each stage the proper pattern is formed as unerringly as water freezes into its hexagons. So long is the series of changes that we might almost say that the organism must have a memory to guide it. But that is to explain a wonderful thing by something still more wonderful. There is in fact nothing in nature by which we can illustrate the ordered series of kaleidoscopic changes through which the organism passes.

As yet I have been speaking only of the wonderful *structures* which the single cell unfolds. It might also seem that there arise in it as it grows *powers* different altogether in kind, not only in degree, from those which its minute self possesses. But there is reason to believe that they are all there in rudimentary form. The amœba, with nothing to help it but the resources of its own little blob of protoplasm, eats, assimilates, breathes, moves, secretes from itself a hard chitinous cyst, has sense of touch and, therefore, potential nerves—all our five senses are varieties of one sense and the brain itself is but a very complicated combination of nerve ganglia—and, as if by volition, selects its food. The Amœba, therefore, is a perfectly generalised cell having all the characteristics of life, so that in the course of evolution we have not to imagine the addition

of absolutely new powers but only the improvement of existing characters by specialisation. These considerations seem to me to make it possible to believe in evolution even when we look only at the top and bottom of the ascent instead of tracing as nearly as we can the slow steps that have led up the incline.

Chapter III

THE LAMARCKIAN PRINCIPLE

Introductory

Now that we have discussed the principle of heredity and found at least a provisional hypothesis to account for the origin of variations, we are in a position to investigate the working of Natural Selection on the material placed at its disposal. But it will be well to put this off till we have seen how far Lamarck's theory rests upon a sound basis. If the Lamarckian principle is really at work in the world, then the part played by Natural Selection is comparatively small. Lamarck, who published his theory in 1801, held that external conditions, such as food and climate, modified the individual and that the next generation inherited the modification. Exercise played a very important rôle.[1] The giraffe's neck grew long from constant straining upward; from constant use the elephant's trunk became a long and perfect grasping implement; much desert walking made the camel's foot what it is; in each generation there was an increment due to exercise, and this increment was handed down to the offspring. Anyone who gives much thought to the subject will see some considerable difficulties standing in the way of the theory. But it is still accepted by a number of biologists who, though they call themselves Neo-Lamarckians, still hold with little modification the theory of Lamarck. The strength of their position lies in this, that they solve or attempt to solve two great problems at once: (1) the origin of variations; (2) adaptation to environment. No other theory, they say, can tell us the cause of variations, no other theory can explain the niceties of adaptation that we see both in plants and animals.

[1] Will, also, according to Lamarck, was an important factor; an individual could by willing modify himself. But as the will uses exercise as its means, I consider that I have included this in my statement in the text.

I am unable to assent to either of these propositions. Indeed, one of the chief objects of this book is to show that the Lamarckian view has no basis in fact and that it offers no explanation of the phenomena of animated nature. I have, therefore, set down some of the chief difficulties with which the Lamarckian is confronted. Most of them he has had to face before and has dealt with, at least to his own satisfaction. Others, I believe, are new enemies to him.

The difficulty of transference from a bodily organ to the reproductive cells

Suppose that any organism has been modified by exercise or by some change in the conditions under which it lives. How is *the modification to be transferred to the reproductive cells and so reappear in the offspring?*

In Protozoa, since they consist only of a single cell and multiply by fission of the entire organism, it is easy to see that inheritance is a much simpler matter than it is in the case of creatures higher in the scale. The experiments which Dr Dallinger made with monads may seem, till they are carefully considered, to prove that the Protozoa at any rate can transmit the qualities they acquire.[1] He found that when the water in which they lived was raised from 60° to 73° F. their vitality and productiveness were much reduced. But after being kept at this temperature for about two months they recovered their vigour. After this they were gradually trained to live at 78° F. "Then a long pause was necessary, and during the period of adaptation a marked development of vacuoles, or internal watery spaces, was noticed, on the disappearance of which it was possible to raise the temperature higher. Thus, by a series of advances, with periods of rest between, a temperature of 158° F. was reached. It is estimated that the research extended over half a million generations."

This experiment, like all the evidence adduced in support of Lamarckism, admits of a non-Lamarckian interpretation. Natural Selection was no doubt at work. Many individuals (I am obliged to dignify these fissiparous creatures by this name) perished because they were unfitted to the changed conditions. This and the acclimatisation of individuals is all

[1] See Lloyd Morgan's *Animal Life and Intelligence*, p. 147, from which I quote.

that we have to postulate. But the latter factor accounts for more in the case of the unicellular organisms than with the Metazoa. Monads multiply by fission. Hence the last *generation belonged also to the first: they were fragments of the individuals that existed at the outset. Thus each new generation would be born with the maximum of acclimatisation yet attained: there would be no delicate period of infancy.* But to speak of transmission seems out of place: except in so far as Natural Selection comes in, we have here merely the gradual acclimatisation of one individual.

The Metazoa present still greater difficulties to the Lamarckian. He has to account for the transference of any characteristic the soma may acquire to the cells whose function is the continuance of the species. But first let me put down a few facts which may seem to tell in favour of the Lamarckian view. Recent research shows more and more clearly the interdependence of the different parts of an organism. The liver, the pancreas, the thyroid gland influence the nutrition of other parts of the body. The reproductive cells do not live entirely apart, but nourish the secondary sexual growths, such as, in birds, accessory plumes. There have been instances of cock-birds, in which only one testis had been developed, having male plumage on the corresponding side and female plumage on the other.[1] The reproduction of lost parts (*e.g.* in crustaceans and in some kinds of reptiles) tells the same tale. In any living organism one part depends upon other parts and it would be untrue to say of the reproductive cells that though they receive nourishment from the body, they stand outside its organisation. There are other parts correlated with them so that if they disappear or are removed these other parts are no longer nourished and do not develop.

But if we concede so much, viz., that secondary sexual growths can be shown to be dependent on the primary sexual organs, we are still very far from allowing that any peculiarity any part of the body may acquire can be transferred to the

[1] See Beddard, *Animal Coloration* p. 262.

reproductive cells.[1] The machinery required is very elaborate. Darwin, as I have already mentioned, formulated a provisional theory to which he gave the name of Pangenesis, according to which every part of the body gave off gemmules or very small *particles and these somehow found their way to the cells from which succeeding generations were to spring. Every other theory suggested is but a modification of this* and must stand or fall with it. There have been found, it is well to own, thin threads of protoplasm which are not parts of the cells but which pass among them and it has been held that these threads are channels of communication. I scarcely think that their existence simplifies the problem. It must be remembered that these countless gemmules from all parts of the body have not only to be conveyed to the reproductive cells and to find their way, some of each kind, into each of them; in addition to this, when they have obtained admittance, we are asked to believe that, the cells do not, like all other living creatures and like themselves when they absorb other living material, treat what they take in as food and assimilate it. On the contrary, the gemmules, according to the theory, maintain their character and—yet another miracle—each finds its place in the complicated architecture of the cell. And how does this affect the question of heredity? This small cell must carry the characteristics of the race. If no additions are made to it except in the way of nourishment which it assimilates, we can imagine, difficult though it may be, that thousands of characteristics are packed, each in its place, within that tiny envelope. But if hosts of new gemmules, each the bearer of some new quality, are constantly knocking and finding admittance, what is to become of the old inhabitants, the gemmules in whose safe keeping are the distinctive features of the race? It is difficult even for the imagination to work out the theory of Pangenesis or any similar theory.

[1] It has been pointed out by Mr Adam Sedgwick that, though the two arms are correlated with one another, yet one may be greatly developed by exercise without the other sharing appreciably in the development. How then should the reproductive cells be affected?

Supposed instances of the inheritance of acquired characteristics

There ought to be no need to write at length on this matter; it has been dealt with fully and clearly by Weismann.[1] However, the wrangling on the subject still continues, and much of it is due to misapprehension. At the outset, it is highly important to explain what is meant by the non-inheritance of acquired characteristics, since there is often a failure to comprehend clearly the question at issue. Suppose that a pianist develops great strength and dexterity of finger, and suppose that his son becomes a pianist and also develops his fingers in the same way. The father, probably, was born with hands well adapted to piano-playing. The son may, very probably, have inherited his power of muscle and bone. The point at issue between Lamarckians and their opponents is whether the son has greater innate capacity because his father developed what he had as a natural gift; whether, in fact, the father through long practice at his art transmitted to his son increased power beyond what otherwise would have been inherited. It is almost impossible to imagine a subject on which it is harder to find positive evidence than on this. The Lamarckians have presented one case after another, and Weismann, as far as I can judge, has disposed of them each in turn. He has been able to show that the predisposition, that made the acquisition possible, has been undoubtedly transmitted, while, as to the acquired increment, the facts do not warrant us in believing in its transmission.

The opinions and practice of breeders

There is one argument of which I do not think enough has been made. The scientific breeder of cattle or any of our domestic animals stands to his animals in the place of nature. He determines what characteristics shall mark the race as nature decides in the case of wild animals. Now, breeders have never trusted much to Lamarckian methods, and, as far as I know, tend to become less and less Lamarckian.[2] No breeder of homing pigeons holds that young birds are any the better if their parents have been highly trained before they bring them into

[1] See his first vol. of Essays: Essay II. on *Heredity* and IV. on *the continuity of the germ-plasm.*

[2] It must be owned, however, that American breeders like American biologists seem to have Lamarckian tendencies. See Cope's *Primary factors of Evolution.*

the world. If a bird wins a prize in an important race, its offspring born before it was highly trained have just as great a market value as those born after. When a race-horse has made a great name, he is often put to the stud and his training is neglected. He is kept in good health, but there is no attempt to further develop his pace. Breeders, then, by their practice, support Weismann. They may hold, it is true, that a particular diet may produce size, and in this view they are undoubtedly correct. But if they assume that the larger build due to such food is inherited, we are at liberty to disagree with them. They not only feed for size, but select for it. The whole result may be due to selection, or, to put it more correctly, those individuals are selected in which the diet in question produces large stature. In the same way, climatic conditions, or the nature of the pasture, affect the wool of sheep. A Shropshire sheep, if transferred to the Cotswolds, becomes coarse in the fibre of his coat. The full effect of the new condition is visible in individuals that have been transferred *after they have attained maturity*.[1] Further evidence, I think, is wanted before we can agree with Professor Cope that later generations exposed to similar conditions show an *accumulated* coarseness of wool.

If we turn to plants, we find the case against Lamarckism still stronger. A gardener is bound to be mainly a Weismannite. He can, it is true, vary the soil, and so, to some extent, the diet of his nurslings, but a plant cannot be trained and exercised as a horse can. The gardener must trust to congenital variations. For these he looks out, and selects the plants that show the qualities that he wants.

It might be argued that, though other characters are not transmissible, this can hardly be true of diseases or immunity from them. Yet there is convincing evidence that here too the rule holds good: acquired characteristics are not inherited. Disease

Civilised man has for many generations been suffering from certain infectious diseases. Among these we may single out measles as a good example for our purpose. Those who have

[1] A noted Shropshire sheep-breeder, whom I have consulted, was most decided on this point.

measles are, in most cases, immune for the rest of their lives. They may come in contact with the germ, but it has no power to injure them. But this immunity is not transmitted to the next generation. On the contrary, we find them, as their parents were, obliged each for himself to purchase immunity by suffering from the disease. Though, however, there is no inherited immunity, there is the striking fact that in the course of generations the disease tends to become milder. The Fiji islanders, when attacked by measles, died by hundreds. Among us the deaths due to measles amount to a considerable number, but not to any large proportion of the cases. Why this difference between English people and Fiji islanders? In the first place, we must allow for the results of careful nursing. But this certainly does not account for the whole difference. It is evident that a race that for generations past has suffered from a disease is better able to resist it than a race that is attacked for the first time. This is certainly best accounted for by the fact that those who were unable to combat the disease have in each generation been weeded out, so that now it is coming to be looked upon rather as a nuisance than a terror. Can the Lamarckians deal with these facts satisfactorily? They may contend that the increased power of resistance, which is generally recognised as existing among Europeans, is the acquired immunity inherited in a modified form. In the case of measles and other infectious diseases which do confer immunity on the sufferer, this may, perhaps, seem to hold. But in the case of consumption the explanation breaks down. And a principle, if it is sound, ought to be of general application.

For hundreds of years past consumption has been one of the most destructive diseases in England; in Cromwell's time, as the bills of mortality show, it was prevalent in London. In the present day, probably about one in ten of the total of deaths are due to some form of tuberculosis. But its destructiveness among the English people is nothing to what it is among savages. If once the germ is introduced among them, they have no power to resist it. Now here the Lamarckian explanation is out of the question. There is no acquired immunity; a sufferer may be completely cured, yet he is at least as liable to infection as a person who has

never been attacked. The comparative superiority, therefore, of Europeans to the disease we are bound to attribute to the constant elimination in past generations of those who were unable to resist it.[1]

There are other infectious diseases which come in a different category and from among them we may select mumps as an example. Mumps as a rule confers immunity on the sufferer, but it hardly ever increases the death-rate and we cannot rank it among ailments that eliminate. Accordingly mumps proceeds on the even tenor of its way. It is what it always has been, a nuisance but seldom more than a nuisance. Were Lamarckian principles really operative among us, it would disappear or at least, mild as it is, become still more mild, following the same course as the eliminating diseases.

The environment cannot change the inherent character of an organ or organism

If it is difficult to show how a modification can be transmitted from the body to the reproductive cells, it is no less difficult to prove that the inherent character of any organ can be changed by its environment. If children habitually go bare-foot, their feet become hard, and this is, no doubt, a modification in the accepted sense of the word.[2] They were born, however, with feet whose nature it was to grow hard if unprotected, and all that has happened, therefore, is that an existing characteristic has been brought out. If gulls are fed on corn they will develop something of a gizzard like the true gramnivorous birds.[3] This may be explained by saying that they are born with stomachs capable of becoming highly muscular should the need arise. A green frog, if he is not among green leaves, but amid dull colourless surroundings, ceases to be bright green and becomes a sombre grey. Put him among foliage again and his green soon returns. It cannot be said that the green foliage has caused his colour to change. It is more correct to say that he has the power of changing his colour to suit his environment.

[1] See *Nature*, April 8, 1897. MM. Bourgatel and Brulfort found that tubercles were invariably present in the lungs of Polynesians whose bodies were submitted to post-mortem examinations.

[2] Modifications, the result of the action of the environment on the individual, must be distinguished from variations, the inborn characters in which an individual organism differs from its parents.

[3] See *Lectures on Comp. Anatomy*, by Sir Evarard Home, Vol. I., p. 271; and *Animal Economy*, by John Hunter, p. 221.

If the frog happens to be blind, no change of colour takes place, so that it is by the help of the eye and the nervous system that the change is effected. In Mr Poulton's book on the *Colours of Animals* will be found an account of the strange power possessed by the pupæ of some butterflies of adapting their colour to the surroundings among which they are placed. Here too the marvel lies in the wonderful power of response to environment possessed by the pupa. It would be strange beyond all comprehension if the environment were able to endow the pupa with its own hue. Animals may live their whole life long in evergreen forests and yet their skin, hair or feathers may show not a speck or a tinge of green. They have no susceptibility to this particular kind of stimulus. When the American hare turns white in winter the old hairs lose their colour, the change usually beginning at the tip, and a great many new completely white hairs appear. The animal, in fact, has the power of turning white when the cold season comes on and of producing a fresh crop of white hair to keep itself warm. It is difficult to see how the cold could cause hair to grow or to change colour, unless the animal in question had the power of reacting to this particular stimulus. *In fact an external condition can do nothing but bring* to light some latent quality. Speaking casually and unscientifically, we may say that being a member of the House of Commons has made so-and-so a fine debater. To put it more correctly, it has developed a power that was already there. Weismann expresses this tersely and well: "Nothing can arise in an organism unless the pre-disposition to it is pre-existent, for every acquired character is simply the reaction of the organism upon a certain stimulus."[1]

A few more instances will help to illustrate this. Ononis or Restharrow varies a great deal in character according to the situation in which it grows. On maritime sands it is armed with strong thorns.[2] When growing in rich soil, and in a moist climate, it is often entirely devoid of them. It has in

[1] Essays, vol. i. p. 172.

[2] When growing by the sea-side and not in a dry sandy soil it is often quite free from thorns. On plants in relation to their environment, see Henslow, *Journal of Linnæan Soc.* (Botany), vol. xxx. p. 218 (1895). There is much valuable information there though I cannot accept his theory.

fact the power of changing and a change of environment awakens this power. The hard thorny plants so common in the desert have become adapted to their surroundings. But the environment has not given them their character. The environment to which they have adapted themselves consists of camels and other hard-mouthed hungry animals that would devour and exterminate an unprotected plant. That the dry air cannot cause the production of thorns is shown by the fact that many desert plants are soft and succulent, protecting themselves by a bitter or acrid flavour. Everywhere we see a close correspondence between organisms and their environment, and yet it is often impossible that the environment can have acted on the organisms so as to cause them to adapt themselves each in its particular way.

It is easy to show how powerless it is. The "locks and keys" of the sycamore (*Acer pseudo-platanus*) twirl round in the wind, when it breaks them off from the branch, and serve to carry the seeds some way from the parent tree to a place where there may be room for a young sycamore to grow. The conditions here are the occupation of the ground near at hand by the parent tree and the possibility of finding room to live and thrive at some distance. Besides this there is the frequency of sufficient wind. But none of these conditions can possibly produce this particular contrivance called, by botanists, a samara, for carrying the seed. Some plants have a kind of spring which throws their seeds to a distance. This too must have been developed without any aid from external conditions, though it is an adaptation to them.

One more example from the vegetable world. The fruits of many plants are admirably suited to attract birds who eat them and scatter the seed far and wide, so that the species extends its range. The strawberry is splendidly adapted to that part of its environment which we call the Blackbird. Yet it cannot have been influenced by the requirements of the palate to which it appeals so forcibly. On its own initiative the strawberry plant produced a marvel of succulence and flavour: this the Blackbird happens to appreciate and, unconsciously, pays for what he receives.

Flowers and Lamarckism What I have said applies equally to the question of the origin of flowers. Here, as with fruits, exercise is out of the question, and how can external conditions shape and colour a blossom? It might have been thought, therefore, that the flower world would have been allowed to be a stronghold of Weismann and his followers and would have been left unattacked by the boldest of Lamarckians. But a distinguished botanist has been bold enough to advance to the attack, and metaphorically it may be said that his bones lie bleaching in front of the walls. Dropping metaphor, we may say that he has supplied an excellent *reductio ad absurdum* of the Lamarckian theory. His view is *that flowers have been produced by insects.* Protoplasm is *irritable and grows when stimulus is applied. Insects crawling over flowers, or the first rudimentary beginnings of them,* have caused them to assume the forms which they have at present.

This is the theory. But how is it possible that the beautiful shapes of flowers can be due to the clumsy scrambling of bees in search of honey? Did so bungling an artist ever turn out so finished a work? No doubt the bee is clever enough in attaining his own ends. But watch him at work and see if he could possibly shape the lip of a corolla. Moreover, besides bees and other welcome insects, flowers have most unwelcome creeping visitors such as ants, and their assaults are guarded against by *chevaux de frise* of hairs, or else the blossom is a hanging bell so that the small crawling vermin cannot get into it. Both classes of visitors, the welcome and the unwelcome, must equally stimulate the protoplasm by the pressure of their feet and bodies. Why is the result so different in the two cases? Why does the flower invite the visits of the one class and bar the way against the other? I am assuming that the flowers require cross-fertilisation and, therefore, welcome those insects that are likely to carry the pollen. But even if this assumption is not made, the argument will hold.

Some flowers have a gay outer rim in which there is no honey, designed to attract insects, while the honey-bearing and fertile flowers in the centre are less showy. This is the case with

many of the compositæ, where the flowers of the ray are barren or partly barren and bees may be seen working away at the less showy centre. Why have not their constant stimulations caused the centre of the daisy, for instance, to sprout into startling forms? and why in the wild guelder rose (*Viburnum opulus*) are the outer barren florets, which insects do not visit, large and showy, while those in the centre, their hunting-ground, are small and inconspicuous?

Finally, if insects by their touch have moulded flowers and given them their present form, to what are the colours due? We want an explanation that will explain both colour and form. And we have it, as I hope to show later, simply in *Natural Selection working on variations.*

The gardener and the breeder as environment

The gardener has done great things. How many roses he has given us! and setting aside mere number and variety how splendid some individuals are! He has been the environment to which roses have accommodated themselves. And yet how can his taste have acted directly upon them and caused new varieties to arise? He may have stimulated them with new-fangled and superabundant manure, and change of conditions will, it is known, sometimes cause a plant to start variations. But the character of the variations has nothing to do with the manure. If we apply the whip to a horse, he may kick or rear or gallop. What he does depends on his disposition. The stimulus applied is calculated to cause a development of energy, but it has nothing to do with the way in which the energy will show itself.

This holds very largely true of the breeder of cattle or horses. The treatment to which he subjects cattle cannot cause them to have perfectly straight backs or to be without horns. The system of training will not turn a carter into a racer or *vice versâ*. And yet the cattle and the horses become adapted to the taste of the breeder. Whatever the explanation, it is not a Lamarckian one.

Exercise and the origination of organs

Let us proceed now to the discussion of exercise and see what results we may fairly attribute to it. It is obvious that a limb may be strengthened. Are not the disciples of Sandow constantly developing the particular muscles that they want? The lungs

may be strengthened by singing, or by systematic breathing exercises. The voice will become much stronger if constantly used in the proper way. Wonderful perfection in the co-ordination of muscles may be achieved by practice, with the result that athletic records, deemed insuperable, may be "cut." But how if we wish to originate a new organ? Without engaging in any definite speculations as to the mammalian pedigree, we may feel sure that there was a time when the ancestors of mammals had no limbs, nor even continuous fins from which limbs were to develop. How can you exercise what does not exist? On Lamarckian principles you can, in theory, account for the improvement and specialisation of a limb as the generations go by. But when it is a question of the origination of any organ, the theory collapses, even if we allow the big assumptions that are made. How did the sense of hearing begin? Exercise failing us, we have to fall back on external conditions. This means that sound striking against the skin stimulated it to sensitiveness and developed the requisite nerves. If it could be so stimulated, it must have already been sensitive, must have already possessed some rudimentary acoustic machinery. This is the conclusion at which we arrived before, that external conditions can originate nothing. We find now that the same thing is equally true of exercise; it is only a stimulus to which the organism responds; it can help a man to attain the maximum development of brain or body of which he is capable. It can give him nothing that was not potentially his at birth.

Exercise and growth

Any one who has read this chapter thus far will see what importance Lamarckians attach to exercise. Its importance for certain purposes is difficult to over-rate, but it is easy to show that it cannot be made to serve the purpose of the Lamarckian.

To begin with, growth in many cases proceeds entirely without exercise. In the vegetable kingdom, if we except certain minute forms of life which the drift of biological theory may any day sweep into the animal world, there is no such thing as exercise. The tree stands motionless and grows. Its sap flows, but there is nothing that we can reasonably call exercise. The minute diatoms protrude tongues of protoplasm and so

move with little jerks. But we cannot connect that with the growth of their flinty coating or of the sheltered cell within. If an organism is to grow, it needs food, power of assimilation, and means of distributing nourishment to its different parts. If it is an animal, it must in addition have oxygen to breathe. But for growth pure and simple, exercise is not wanted by an animal any more than it is by a vegetable. A chicken within the egg has little opportunity for taking exercise: yet, cramped in his narrow prison, he goes through the most important stages of development and at length emerges, able to move about, endowed with something in the way of instinct and with brain sufficient to learn quickly from his mother's teaching. The altrices, the birds which are born helpless and remain for a time in the nest, attain almost their full size before they take any vigorous exercise. A young albatross is fed up till he is a perfect mass of fat and heavier than either of his parents; in this condition they leave him in the nest to develop. And as everyone knows, he does—staying sedentary in the nest—grow into a very glorious bird.

The embryo of any of the higher mammals passes through a wonderful series of changes, and is structurally not far from the mature phase, when at length it sees the light and knows the delights of exercise and play. In a later chapter (pp. 117, 121) I shall return to the subject and try to explain the rôle that is assigned to exercise in nature. Enough has been said to show that it is not at the disposal of Lamarckism.

If exercise is not necessary to growth, it would seem to follow Disuse that disuse, even if almost complete, will not arrest development altogether. In some cases it certainly does not. Even when for good and intelligible reasons growth has become associated with constant exercise, we do not find a very great shortcoming in a particular organ of which little use is made. In some breeds of domestic ducks that have given up the habit of flight, the wing bones (humerus, radius, carpo-metacarpus) are in *actual measurement* longer than in the wild duck (*Anas boscas*), though shorter *relatively to the leg bones*. No doubt the wing development is less than it would be with more active habits.

But the reduction is not very great, and it must be remembered that the huge weight of the Aylesbury duck, for instance, as compared with the wild duck, is due to a general increase in size, and that in this increase the breast muscles, *i.e.* the muscles of flight, have shared, the breast bone from which they spring being much larger than in the wild ancestors of the breed. Selection for bulk has brought about an increase in spite of disuse.[1]

Weismann attributes to disuse effects which seem to me to be due to a different cause. "We know," he says, "that, as a matter of fact, the olfactory organ of a frog completely degenerates when the olfactory nerve is divided; and that great degeneration of the eye may be brought about by the artificial destruction of the optic centre in the brain."[2] This shows that the olfactory organ and the eye cannot be healthy when severed from the lobes of the brain in association with which they work. This is quite different from mere disuse. He himself in the same essay[3] points out that the flight muscles of the domestic goose have not undergone any marked degeneration.

Vestiges

I will now discuss the question of the rudimentary or, as they are better named, vestigial organs. Examples are easy to find. Man is still possessed of muscles for moving his ears forward, though he has altogether lost the use of them. The apteryx, or kiwi, the New Zealand bird that has lost the power of flight, has still beneath its feathers the chief wing bones, reduced to minute dimensions. The python has tiny hind legs bearing claws that just appear through the skin. The slow-worm has a remnant of a shoulder girdle and in the embryo there are short stumps representing the forelimbs. The blind cray-fish have eye-stalks and some vestiges of eyes though their sight has gone.

Take the apteryx with its much reduced wings as a typical example of such phenomena. Suppose the reduction in the size of the wing to be due to disuse. Then, in the early stages when disuse was incomplete, the process of reduction would be very

[1] See Darwin, *Animals and Plants under Domestication*, vol. i. p. 84.
[2] Essays, vol. i. p. 87. [3] *Loc. cit.*, p. 91.

slow. But when the wing had become so small, that exercise was out of the question, then we should have expected all trace of it to disappear rapidly. Now this is just what in this and hundreds of like cases we do not find. When once the organ has been reduced to the point of absolute uselessness, it often lingers on with astonishing persistence, though there are, it is true, many examples of complete disappearance. Of the five digits of the normal hand the bird has only three remaining, and of the two missing probably only one is represented by a trace in the embryo.

Such instances of complete loss do not in the least stand in the way of my argument, which is this: If partial disuse can greatly reduce an organ, complete disuse ought in every case to cause its total and comparatively rapid disappearance. If it be urged that all vestiges are gradually vanishing, the answer is that in many cases organs reached the vestigial state ages ago and still they linger on. For ages the horse's forefoot has borne only one toe and yet there still remain the two so-called splint bones, that once carried a toe on either side.

I have tried to show that the Lamarckian explanation of vestiges fails to explain the facts. There is what I consider a satisfactory explanation which I hope soon to put before the reader. I propose first to take some other problems which Lamarckism fails to solve.

The stag's antlers

Mr Herbert Spencer has written much on this subject. To him the great antlers and the great development of muscle and ligament for carrying them, present a phenomenon for which we can account only if we consider the various associated developments to be the inherited results of exercise. We can imagine, he says, that congenital variations might be accumulated, and the antlers by themselves might be accounted for in this way. But they would be an insupportable burden, did not other variations arise simultaneously giving the body the strength to carry so great a weight. Such *co-adaptation* and *co-operation* can be explained, he contends, only on Lamarckian principles.

He has chosen this battlefield for himself, and considers that here he has a very strong position. The problem which he has

presented to the Neo-Darwinians, *i.e.* to those Darwinians who have thrown overboard Lamarckism, is certainly not a very easy one. The next chapter is to be constructive and there will be the place to show how Natural Selection unassisted, can deal with it. (See p. 122.)

At present I will only show that at one point his own position is utterly untenable. The antlers themselves, Lamarckians hold, originated from the fights of rival bucks. They were constantly butting each other and the bone of the skull thickened at the place which was most buffeted. Hence the antlers of, for instance, the wapiti! We may assume, what I have tried to show is impossible, that constant blows could *produce* thickness of bone, not merely stimulate the bone to put forth what power of thickening it had. Granting this, we have next to assume that *mere random knocks could produce the beautiful branching of the antlers. Was there systematic hammering at the point where a branch or tyne was to arise? But if this view of the antlers is* discarded and they are attributed to Natural Selection acting upon congenital variations, while the supporting muscles are explained as the inherited result of exercise, then we have two principles which, to say the least of it, are not very good yoke-fellows, expected to pull together.

The skill of neuter insects

How to account for the skill of neuter insects has been a familiar problem since Darwin's time. The wonderful architecture of the cells made by bees has impressed everyone who has thought of the matter. Now the skill of the worker bee is born in her: it is not due to a laborious education. And it cannot be that skill acquired by practice by former generations of workers has been transmitted as an instinct to the bees whom we watch at work. The worker bee leaves no offspring behind her. The whole hive are the children of one queen. She herself displays no skill except in depositing her eggs and in carefully distinguishing between those that are to develop into drones or into workers. She is no builder like the ordinary working members of the hive. If, on occasion, intelligent adjustment to new conditions is required—a modification of the stereotyped architecture to suit a novel situation—it is the

neuters who then come to the front, and subsequent generations cannot possibly inherit the acumen and resourcefulness that result from such exercise of the faculties.

Let us see how this difficulty has been met by Lamarckians. The bees, they say, gained their skill before the division of labour in the hive was carried so far, before all the egg-laying was done by one female only, at a time when each female not only worked but also produced offspring. But is it not reasonable to suppose that the improvement in skill has gone on hand in hand with the division of labour? And surely the same principle to which the development of this skill is due must now be maintaining it. If practice has produced results so extraordinary, how does it happen that there is no deterioration, though for an enormous succession of generations the parents, male and female, have given up all practice of the art?

The skill of caterpillars

I shall now select from insect life two or three examples of a most wonderful phenomenon. Some insects have once only in their lives to do work that requires the utmost skill. When a caterpillar has grown to his full size it is time for him to make a chrysalis, and if he does not make a really good one he has little chance of ever emerging as a butterfly or moth. Some cocoons are spun in an extremely clever way and the point which I wish to lay stress upon here is that the skill cannot be the inherited result of practice. Once and once only does the caterpillar try his hand at such work and very beautifully he does it. There are now at the Insect House at the Zoological Gardens some cocoons spun by the caterpillar of the *Rhodia fugax* moth from Japan. The top is left slightly open so that the moth may be able to escape. And, presumably, since water might find its way in at the aperture, a very neat little hole, that looks as if it were hemmed round the margin, is made at the bottom for drainage purposes. This at least I imagine to be the object. I mention this because we are so familiar with the spinning of caterpillars that we have become dulled to the wonder of the phenomenon. The little speciality in the spinning of *Rhodia fugax* reawakens us and enables us to realise the cleverness, if that word is suit-

able, of the feat performed, for instance, by the caterpillar of the common silk moth when it spins its cocoon.

The Yucca moth

But this is nothing compared with what is done by a Californian moth, *Pronuba yuccasella*, for a full account of which I refer the reader to Kerner's *Natural History of Plants*.[1] The caterpillar of this moth lives on the seed of the Yucca plant; this plant cannot fertilise itself, but must have pollen brought to the stigma. The Yucca moth, armed with special appliances, not only deposits its eggs where the caterpillars when they emerge will have proper food, but accomplishes the transfer of the pollen. At night when the yellowish white flowers are open and visible in the moonlight, she starts forth on the important business on which depends the continuance of her race. She enters the bell of a flower and collects a ball of pollen. For this purpose she makes use of the elongated first joint of the maxillary palp, "the inner surface of which is beset with stiff bristles and can be rolled up like a trunk." With this she seizes the pollen, rolls it into a ball which is sometimes three times as large as her head. She then flies to another flower and proceeds to deposit her eggs at the base (which in a hanging flower is uppermost) of the pistil. This she does by means of an ovipositor consisting of four horny bristles which are able to pierce the hard tissue. Having laid her eggs she goes to the *top of the funnel-shaped pistil and stuffs the pollen into the mouth of the funnel.*

I will now draw attention to the various points that strike one as one reads this remarkable story: (1) The adaptation of the maxillary palp and the ovipositor; (2) the correct use of the special apparatus; (3) the fact that the individual moth gains nothing by the whole business; (4) that each moth has only once in its lifetime to do this work; (5) The circumstances seem to make it impossible that there can be any imitation, any learning on the part of one individual from another. In the presence of such facts what becomes of the Lamarckian hypothesis?

One other point I must mention though it does not bear on

[1] Vol. ii. p. 156.

our present subject. In each ovary of the Yucca flower there are about 200 ovules. The grub of the Yucca moth does not eat by any means all of these and quite enough are left. Apparently, cross-fertilisation is so important to the plant that, in order to obtain it, it is worth sacrificing half the ovules produced.

It is among insects that we find such instincts most perfectly developed. In every case the fate of the species depends upon the exact performance of a difficult work, and it would seem that Nature dare not entrust this work to intelligence that can learn only by blundering. But though such instincts are found in their most elaborate perfection among insects, it is upon instincts among other animals also that the propagation of the species depends. And for the existence of these Lamarckism is unable to account.

Lamarckism and Weismannism side by side

In speaking of the antlers of the stag and the various co-adaptations I pointed out how difficult it is for Lamarckism and Weismannism to go in harness together. We must trust either to the inheritance of acquired characteristics or to Natural Selection, always ready to make use of so-called spontaneous variations, but not to the co-operation of the two principles. It is true they are not diametrically opposed to one another, and Darwin himself did not entirely exclude the former. But if not mutually antagonistic, it is difficult to make them pull together *when we find them at work in competing species, or in one and the same organism.*

I shall show in the chapter on Natural Selection that when one species preys upon another the two must advance *pari passu*, else one of two things must happen: either the preyed upon will no longer be caught and killed (with the result that their enemies will starve), or the preying species will annihilate its means of subsistence. Suppose that a species of butterfly protects itself from birds who live upon it by resemblance to the leaves of trees. If the resemblance becomes too exact the bird will search in vain, and must either go unfed, or seek some other food. If, on the other hand, the bird's eyesight improves more rapidly than the protective coloration of the butterfly, then it is likely that this

species of butterfly will disappear from the earth. Now the colour of butterflies is in the scales that clothe the wings and body, and these scales are dead structures. They cannot be exercised; even if they could, it is difficult to imagine that their colours could be altered by such means. On the other hand, the bird's sharpness of sight may improve with practice, and, according to Lamarckians, such sharpsightedness may be transmitted to subsequent generations. Here, then, we should have birds that have Lamarckian principles to help on their evolution, preying upon butterflies whose progress in protective coloration must be on Weismannite or Neo-Darwinian principles.

FIG. 9. — Primary wing feather of heron. The outer web is narrow.

In one and the same organism we might find the same incongruity of rival systems. Birds *improve their flight muscles by practice. Many of the best flyers can be seen enjoying themselves in the air,* systematic, if unconscious, assiduity, beyond that of any gymnast, leading them towards the goal of perfection, towards perfect development and co-adaptation of many muscles, perfect knowledge of gusts of wind and how to deal with them, perfection at every acrobatic feat that the practical needs of life may call upon them to perform. If Lamarck was right, how rapidly such a species must acquire and co-ordinate all the muscles that flight requires! How slow, on the other hand, must be the improvement of dead structures, such as feathers, for which no exercise is possible! And yet the adaptation of the feathers to the needs of flight is as perfect as the adaptation of the muscles. To give the wing its rounded concavity beneath and make it impervious to air, the outer webs of the great flight feathers have been much reduced in width. The air acting mainly on the broader

web tends to turn the feather on its axis, and force the inner side upward, pressing it closely against the feather next to it. The same contrivance rounds the tail and makes it useful as a parachute. I say nothing about the marvellous interlocking of the barbs.[1] No further description is wanted to show that the feathers are as perfect as the muscles that move the wings. How can we believe, then, that the feathers have been handicapped by being debarred from a means of progress which has been available for the muscles?

I will briefly mention here what has been urged by an enthusiastic Lamarckian on the subject of feathers. Though they are themselves dead structures, yet they spring from papillæ in the skin and are moved by muscles which move the skin. Birds which display their plumes have, he maintains, developed them through exercise. The peacock's enormous tail-coverts have resulted from his constant habit of displaying them! This is Lamarckism run wild. It is enough to say that *if exercise were the cause of a feather's growth, then the eagle's great remiges, that do a thousand times as much work as the* peacock's plumes, would never have had their outer web reduced as it is, and the peacock's dowdy and comparatively short tail feathers that support and help to move the lordly tail coverts would have been very different from what they are, were exercise of the associated muscles all that is required to produce nobility of plumage.

When Weismann has been worsted in controversy it has often been through the cumbersomeness of his own armour rather than the skill of his adversaries. Notably has this been so when, arrayed in his elaborate panoply of biophors, determinants, ids, idants, he has tried a tilt with them on the much-vexed question of the reproduction of lost parts. When a cray-fish loses a claw, he proceeds to grow another. The salamander is celebrated for its power of replacing lost limbs. How explain this, he is asked, if the germ-plasm lives apart? Then appear the armies of determinants that he has called into being and he marshals them, each in its place, not without difficulty. This I cannot

Reproduction of lost parts

[1] I have described this in my *Structure and Life of Birds*, pp. 147-149.

help regarding as a self-imposed burden, as I have already said.[1] I wish now to point out that the reproduction of lost parts should be the *bête noir* of the Lamarckian rather than of the Neo-Darwinian. For it is clear, when a lobster replaces a lost claw, that nothing external is the cause of the re-growth; the loss has merely stimulated the organism to put forth a power that belonged to it at birth, viz., the power of replacing a lost limb.

The mutilation of embryos brings out this power in a still more marked way. When the egg of a sea urchin is in its second stage, no longer a single cell, but two cells united, it has been found that if the two components are separated, each cell will develop as if no separation had taken place and will even *advance to the gastrula stage. What better evidence can we have that no external influence shapes the embryo, but that it develops according to its own laws? It is true that some experiments on the eggs of frogs have not given the same results:* when one cell, of two or four developed from the single original cell, was killed (not separated), it was not replaced, but here the conditions seem to have been unfavourable.[2]

The experiments on the sea urchin's eggs show how strong and persistent is the character of the germ-plasm, how capable it is of piloting itself. We must go beyond mere externals if we wish to find the cause of variations. Weismann, indeed, concluded that the germ-plasm might be influenced by external conditions acting upon it directly, not indirectly through the soma, but such influence I regard only as a stimulation to the organism to vary, not as a cause of variations, since the growth that results is often in no sense an adaptation to the conditions that are said to have produced it.[3]

Selection of food

There still remain difficulties to clear up. It is often urged that the germ-plasm depends entirely for its nourishment on the individual, of which it forms part or in which it resides, and that its character must depend largely on the diet which is supplied to it. This argument looks formidable at first sight. We must remember, though, that you may take a horse to the

[1] See pp. 53, 131. [2] See Weismann's *Germ Plasm*, pp. 136, 137. [3] See p. 53.

water but that you cannot make him drink. An organism selects from the materials that come in its way those that it can digest and assimilate. A plant takes from the ground what its special organisation requires. In the same way the cells in the alimentary canals of the higher animals select what is suited to the organism of which they form part. If a man lives entirely on meat, he nevertheless extracts from it a sufficiency of certain substances that he could with greater ease obtain from vegetables. No organism, therefore, derives its character from its diet. No form of food can exert any influence till it has first been admitted to the system. And the environment cannot exercise any compulsion; you may make a man eat under threat of torture, but the special selective cells of the alimentary canal cannot be thus tyrannised over: they are the proverbial horse that cannot be *made to drink. They take up only what they "choose." Now the germ-plasm in the reproductive cells is nourished by the soma: there is no other possible source of nourishment. But the soma* assimilates what its congenital constitution has given it the power of assimilating; the germ-plasm has the same congenital constitution, and how can it be modified by what is, in its nature, the same as itself?

Hence the germ-plasm cannot be freely experimented on by the soma and subjected to all sorts of changes of diet. It is true that the nourishment may vary as to generosity. But it is easy, I believe, to over-estimate the importance of this concession. The organism makes the reproductive cells its prime care, the continuance of the species taking precedence of all other objects. Hence hunger and hardship do not tell upon them as they do upon the individuals who are, as it has been put, the trustees of the species. It is only by assuming this, that we are able to understand the rapid rebound of which, as experience shows, a race is capable. They are stunted and degraded by squalid conditions, yet if the children of this stunted and degraded population be taken at an early age and put in a better environment, the return to a better physique is astonishingly rapid. It would be still more striking if the experiment were made in the first year of infancy.

A seeming concession

Here I must briefly anticipate a difficulty with which I shall deal in the chapter on Natural Selection. Though external conditions cannot cause a particular variation, yet they may stimulate variability. What happens I imagine to be this. Natural Selection is constantly strengthening heredity. As long as the same characteristics continue to be selected for survival, that is, as long as the conditions remain the same, the species *attains greater and greater fixity. The deviations from the normal become smaller and smaller. But, when there is a change of conditions, variability shows itself. The variations are not necessarily adaptations; more frequently they bear no* relation to the new circumstances. The change that appears in wild ducks after several generations of domestication is a well known instance of this. The white collar round the neck of the Mallard becomes much broader and more irregular and white feathers appear in the duckling's wings.[1]

Sometimes variations induced by change of environment become constant, though Natural Selection, as far as we can see, does not intervene to stereotype them, and here we enter upon one of the most difficult parts of our subject.[2] I shall have to refer to it again. At present, it will be enough to say that Lamarckism derives no support from the facts. There is merely a shift to another position (already possible to the species but previously ruled out by stringent Natural Selection, or some other influence but little understood), or else a failure of heredity, a failure to build up to completion all that has become evolved in the course of the phylogeny. For the Neo-Darwinian the only difficulty which the facts present is the apparent existence of stability apart from the operation of Natural Selection.

Summary

I have tried to show that it is very difficult even to imagine the means by which acquired characters might be transferred from a bodily organ to the germ-plasm: that breeders hardly

[1] Mr Hewitt, quoted by Darwin, *Animals and Plants under Domestication*, vol. ii. p. 263.

[2] See Prof. Adam Sedgwick's address, Brit. Association, 1899 (*Nature*, Sept. 21); also Prof. Mark Baldwin's letter in *Nature*, Oct. 19, 1899.

take into consideration the possibility c' such transference and that even in the case of disease, direct evidence is difficult to find: that neither exercise nor external conditions can change the nature of any organism, but can only develop characters that are already present. "Every acquired character is," as Weismann has put it, "simply the reaction of the organism upon a certain stimulus." No organ can be originated by exercise, *though an existing organ may be developed to its maximum. The Lamarckian view of exercise is incorrect: growth does not lepend on exercise except under certain circumstances where he association of the two is not difficult to explain.*

However close the correspondence between an animal or plant nd its environment, it is easy in many cases to show that the daptation that has arisen cannot possibly be due to the direct ction of the environment. Lamarckism fails to account for the ntlers of the stag, for the skill of the worker bee, for the ocoon-spinning of the caterpillar or the remarkable instinct of ıe Yucca moth. In some cases the Lamarckian principle cannot ossibly be applied and we have even in one and the same ıimal to imagine it working side by side with a principle that, not actually antagonistic, is yet incongruous.

The reproduction of lost parts by embryos shows that the rganism, even at that early stage, follows its own course and is ɔt the creature of circumstances. The argument that variaons may and must be caused by diet is unsound. The organm does not passively submit to the influence of any diet that ay be served up to it, but selects in accordance with its own herited character, and this character has been inherited equally y the germ-plasm.

If there is any force in what I have urged, Lamarckism fails make good either of its contentions. First, it cannot account r the origin of variations; secondly, granting for the sake of gument, that there are such things as acquired characteristics, e evidence of their transmission is unreliable; the machinery the organism by means of which they can be transmitted has 't to be discovered.

Chapter IV

NATURAL SELECTION

I

NATURE OF THE STRUGGLE FOR EXISTENCE

Difficulty of realising that there is any struggle going on

THERE is a struggle for existence perpetually going on and those individuals or species, who cannot contend against their competitors or the physical conditions under which they have to live, are eliminated. The survivors are the picked few out of an enormous herd.

It is very hard to realise this when taking a walk in the country and looking upon an ordinary English landscape. The oak trees stand apparently unassailable, making light of their many insect enemies. The flowers seem full of superabundant life and the bees seem to be no more than healthily busy. The birds sing as if life for them were all jollity. The rabbits feed as if stoats and other enemies were too rare to affect their happiness. The ploughman does not go about his work as if there were any danger of his being eliminated for want of energy. Sometimes the scene is well described by Tennyson's lines:

> "A sleepy land where under the same wheel
> The same old rut would deepen year by year."

Often the happiness and jollity is more apparent than the sleepiness. Except on comparatively rare occasions when we come upon a butcher-bird's larder, or see a sparrow-hawk after small birds, or a stoat pursuing a rabbit, the struggle for existence is not forcibly obtruded upon us.

Yet it is very easy to show that the struggle is very real and that only a small minority survive. Take house-martins[1] and

[1] Chelidon urbica.

consider their rate of increase. It is quite common for them to have three broods in the year and we are not beyond the mark in allowing them four in each brood. In order to avoid any possible exaggeration we will assume that each pair has eight young ones each season. At this rate, if there were no deaths, there would in five years be six thousand two hundred and forty-eight house-martins sprung from one pair.

It is quite true that with many animals the rate of increase is much slower. But if we take the least promising instances, the results, when we work them out, are astonishing. The elephant is believed to be the slowest breeder of all known animals. Yet according to Darwin's familiar calculation, "*after a period of from seven hundred and forty to seven hundred and fifty years there would be nearly nineteen million elephants alive, descended from the first pair.*"[1] *And in many species, and notably among plants, the rate of multiplication is far more rapid than it is among* house-martins. Well known as these facts are, it is well to emphasize them, because there has been a tendency of late among many biologists to underrate the power of Natural Selection; to say, "It may account for some facts, but evolution must have gone on, to a great extent, independently of it." I believe this idea is partly due to failure to realise the enormous amount of elimination that is constantly taking place. As a general rule a species about maintains its numbers; in some there is a tendency to increase, in others to slowly diminish. And yet it is obvious that if there were no natural check, any species would in no great number of years people the whole world to the exclusion of all others. Such a thing is impossible, since no species of organism, except perhaps some of the very lowest, can live isolated and independent of all other species. But to say this is only to mention one of the natural checks that stand in the way of unlimited increase.

In September, in parts of the coast where sea-gulls congregate, it is easy to convince oneself that the majority are immature birds. They wear the garb of youth, and that though in herring gulls (*Larus argentatus*), the species perhaps most

[1] *Origin of Species*, p. 51 (6th edition).

commonly found, the mature plumage is not assumed at any rate till after the third year. Yet next spring you find that the majority are birds that have doffed the brown of childhood and donned the white and grey of mature life. What has become of the one-year-olds and two-year-olds?

Sea-gulls can stand a great deal in the way of cold. No severity of frost prevents them from fishing or even bathing for pleasure. But it is difficult to imagine that this hardiness can be maintained by any means but elimination. The difficulty of finding food must dispose of a great many; they often fish and catch nothing. Storms may carry not a few out to sea. Death in some form has claimed them.

What an enormous host of migratory birds start southward from our shores in autumn! During their stay with us they have certainly trebled their numbers and yet next spring there are no more than the last. Most of the young birds have gone astray, in stormy weather have failed to reach the shore, or have failed to get food or have met with enemies. If migration entails such a death-rate, it has been urged, why have birds formed so foolish a habit? But those species that winter at home do no more than keep up their numbers and in that the migrants also succeed.

In the two cases mentioned physical conditions act very severely and it is not probable that in England birds of prey and other enemies play more than a secondary part. But we may be sure that it was otherwise during past ages when birds we are familiar with were being evolved. Even now there are sparrow-hawks, crows, magpies and jays in plenty in our islands and they are constantly at work on small birds or their eggs. Birds of prey able to tackle a sea-gull are not so common, but they are by no means extinct. And in addition to these beasts of prey there is the rapacious and almost ubiquitous boy birds-nester and in the case of rare species, the pestilent adult collector.

With most animals, now as in the past, the struggle is mainly one against enemies. Antelopes are pursued by lions and other beasts of prey. The tiger is the greatest danger

some animals have to encounter, among them the wild boar, whom Sir Samuel Baker counted as the bravest of the brave. Sportsmen and stoats keep down the number of rabbits, for physical conditions with us are not often severe enough to kill them. But with all species it is clear that disease must account for a good many deaths. It is true that we seldom find any sign of it among wild animals. The explanation, however, is clear enough. Any ailment must speedily be fatal, and individuals that have any congenital tendency to disease cannot live long enough to leave any offspring. We find a considerable crop of diseases making their appearance among domestic animals. They are selected because of some particular points which commend them to the fancy of the breeder, not, like wild animals, because they combine very great vigour with the other characters that are necessary to the race.

The struggle between groups

The struggle is not always one between individuals, but a herd of cattle, a rookery, a hive of bees, combine against all-comers. Prince Kropotkin has, in some very interesting articles, brought out clearly the fact that among animals there is an enormous amount of mutual help. Nothing can be more true. Wherever species are gregarious, they associate together for the good of each and all. This does not prevent wrangling and quarrelling, and gulls may often be seen on their feeding-ground disputing over a sand worm or other choice morsel. Still they keep together because they are sociable and friendly, and very possibly, like rooks, mob a bird of prey on occasion. But this friendliness never leads to any mitigation of the struggle of the individual against disease. A sick bird is not fed or tended in any way.

Sometimes birds of one species help those of another, but this is probably quite unintentional. The curlew (*Numenius arquata*) gives a signal which puts up numbers of other birds, and the shore-shooter is angry and depressed.

The combination is usually, but by no means always, for defence. A hive of bees will make a combined attack upon another and oust them, and several rats will band

together when goaded by hunger and devour a weak fellow-rat.

This principle of mutual help mitigates in a way the horrors of the struggle for existence. But it does not in the least alter the cardinal fact. The supply of food is limited, and those who cannot by strength and courage or cunning get a share must starve. Sometimes physical conditions may be the most formidable enemy, but in almost every case an animal has animal enemies as well. Everywhere there is war from the polar regions to the tropics, and in order to hold their own some animals have found it best to combine. They fight in armies, or in small companies instead of individually. This does a good deal to ennoble the war, though it does not prevent it from being war. It has introduced in many species a love of society without reference to the need of combined offensive or defensive action. This must be the case unless we interpret the conduct of sociable animals quite wrongly. Rooks must enjoy each other's companionship when they fly round and round in huge clanging flocks before they settle to roost. If gulls are unsociable, why do a troop of them together practise their evolutions in the air instead of each of them retiring to a solitary place? The fact is that characters that are stamped on a species by Natural Selection because they are useful, show themselves on occasions when nothing is to be gained by them. Among social species the exercise of the social instincts is one of the joys of life. All animals rise above a mere business spirit. The horse delights in putting forth the speed which he has gained to save him from his enemies.

Love of society

Crises and calm intervals

If the struggle is really serious, how does it come about that plants and animals have such a superabundance of vigour? If species, as a rule, can only just maintain their numbers, how is it that the component individuals, when we happen to see them, seem to have a superfluity of energy, seem not to feel the grip of the ruthless system? This is due to the fact that the struggle comes only in crises. At such times the conditions of life are so hard that only the strongest in each species are equal to the strain, and even they have only a bare margin of superiority.

Between the crises there is peace and happiness. There is often, it is true, an unceasing alertness well suited to an atmosphere of danger. But the alertness seems due to an unfailing protective instinct, not to nervous anxiety. A curlew has no nerves. Moreover there is no painful memory of past perils till something arises to recall them. Of this we may feel reasonably sure, since animals express the emotion of fear in a way that admits of no misinterpretation.

The commonest crisis of all is that which comes in early youth. When in the nest, the young sparrow lives like a fighting cock, caterpillars are brought to him by the score. But when he emerges he must very soon begin to fend for himself, and if he fails in energy or nous he will soon be no more. But should he succeed in surviving this time of trial, he may live for some years vigorous and joyous. A hard winter may mean another crisis for him. If he survives this, being good at finding food where others would starve, or getting more than his fair share by hard fighting, it means that in ordinary weather he will have a surplus of energy.

The young swallow has hundreds, or perhaps thousands, of flies and gnats brought him daily while he is still in the nest. When he is first trying his wings his parents will come alongside and in mid-air put flies into his mouth. But this soon comes to an end. He must forage for himself or starve. This is his first great trial, but soon another is upon him. He must either find his way to Africa and spend the winter there or die in England. Supposing that he reaches his destination, the winter time in the south has probably no very great danger for him. But in the spring an uncontrollable instinct comes over him. He must fly northward and face storms and all the dangers of travelling. Here there is another crisis. If he survive this, it is probable that the path of life will be smoother for him. Experience has robbed migration to a great extent of its dangers. Food is plentiful both in his summer and winter homes, and there are not in the present day many hawks, in his northern home at any rate, that can catch him.

For our birds at home a hard winter is a trying time, not so

much owing to the cold as to the difficulty of getting food. In England droughts are not as a rule prolonged enough to bring distress to wild animals, but in other countries they are among *the greatest exterminators. An Indian famine leaves a great dearth of animals in the districts that have suffered. I have read of the rush of wild animals in Africa in times of drought to* the *pools still remaining* in the river-courses. Only the more vigorous succeed in reaching the water or are able to hold their own among the herds maddened with thirst whom they find there. In some regions famines and droughts are entirely absent, but none the less there are crises which eliminate the weaker of each species or those less adapted to their surroundings. Of such regions of the earth the equatorial are perhaps the best example.[1]

In three years at Batavia, on the north-west coast of Java, the range of the thermometer was only 27° Fahr., the maximum being 95°, and the minimum 68°. With us the thermometer will rise to over 80° in summer, and in winter descend till it is not far from zero. This gives a range of some 80 degrees. Then in our islands there are great variations in the amount of food obtainable by wild animals. In the equatorial zone the amount is always large, and does not vary very much in amount.

In such regions physical conditions being uniformly favourable evolution has been due almost entirely to the interaction of species. For an individual a crisis comes when he is pursued by an enemy—for a species, when some rival species devours all the food that used to be shared; or when it finds that its old enemies, that have long hunted it, have improved in eyesight, in quickness, in cunning, or in weapons of attack. Here too, therefore, there are crises and pauses, and the struggle for each individual is not incessant.

The howling monkeys, whose cries were so hideous and depressing to Mr Bates, no doubt have a great fund of vitality that is only wanted for serious business on special occasions. The same is true of the parrots, the toucans (ramphastos), the

[1] For an interesting account of the equatorial regions see Dr A. R. Wallace's *Tropical Nature.*

humming-birds, the countless butterflies, the ants, the lizards, and the snakes.

Crises in the lives of plants

Are there crises in the life of a plant as in that of an animal? No doubt there are occasional emergencies—*e.g.*, extreme cold or a drought, when even the deepest roots can find no moisture and the air contains but little. But, speaking generally, a purely vegetable existence is not marked by the ups and downs that come in animal life. A plant can store up food, or rather its products. A deciduous tree, after the leafless time of winter, is able suddenly to cover itself with foliage. In its bulb a hyacinth has a great depôt of nourishment that enables it to be ready at the first appearance of spring. An animal, a bird or mammal at any rate, is an engine that requires constant stoking up. Hibernation is rather a proof of this than otherwise. So small is the store of nourishment that a marmot can put by, that, to make it last any time, he must husband it by remaining torpid. Still, even among plants, there are terrible crises, though, as a rule, they do not affect well-established individuals. In a tropical forest all the ground is occupied. There are the giant trees and creepers clinging to them and hanging in festoons. There is an undergrowth of smaller trees, and often, under that, a third growth of comparatively dwarf trees, while perhaps the ground is covered with selaginella.[1] At length one of the giants falls and carries destruction with him. Light is let in, and among the seeds of all the neighbouring trees there is a struggle, as in the Black Hole of Calcutta, to get near to the window. For through that window in the dense canopy comes the sunlight that to a vegetable is the very elixir of life. For years and years the trees round about have been producing seeds by the thousand or million, none of which, unless transported by birds or other carriers, had any chance of growing. Now at last has come an opportunity. In the opening numbers of young trees will spring up, but only a very small number will survive. The rest will be shut out from the light by quicker-growing or more vigorous competitors. Such things may go on in English woods; but man interferes a great deal with the processes of nature, or, to put it

[1] Dr A. R. Wallace's *Tropical Nature*, p. 34.

more correctly, he is a new feature in the environment, and it often happens that a tree or a flower accommodates itself to him and his caprice rather than to vegetable competitors. Were the interaction of plant upon plant left unrestricted, man's favourites would have little chance of survival. Give your weeds a fair chance, and you will see only a few more generations of your wheat.

Forest fires

A forest fire must mean a grand opening for a readjustment in the relations between competitive species of trees, and there is reason to believe that, before man learnt the art of kindling fire, conflagrations were of sufficiently frequent occurrence to help on the evolution of plants. Volcanic eruptions must have occasionally set fire to surrounding vegetation, and it is quite possible that accumulations of dead leaves may have heated and smouldered, and at last burst forth into flame. More often, probably, a flash of lightning started a conflagration. A great forest fire gives a grand chance not only to enterprising species of trees, but also to smaller plants, whose seeds seem to lie dormant waiting for such an opportunity.

To show how important it is that an organism should be ready to meet an occasional emergency, I will mention what Kerner gives as the reason why nearly all the trees in northern latitudes have developed a means of shedding their leaves and have become deciduous. Snow, he maintains, is the cause of the phenomenon.[1] The few native evergreens that we have are able through the slipperiness of their leaves, or the small surface they expose, or through the elasticity of their twigs, either to shift the snow or remain unharmed by its weight. But most of our forest trees have very different foliage. Kerner describes the disastrous effects of a heavy fall of snow in autumn or spring when every tree is in leaf. In our mild island climate this is not likely to happen so often as in Germany. But most of us can remember an instance of a cedar tree losing some of its big boughs through the weight of snow. And we may feel sure that many tropical trees, exposing as they do a great breadth of leaf, would be impossible in countries in which snow occasionally lies deep.[2]

[1] *Natural History of Plants*, i. 358.

[2] No doubt cold hastens the fall of the leaf, *i.e.*, sets the machinery in motion.

Even for plants, then, there are crises. Among animals, however, they are far more frequent, a fact that must be borne in mind if we wish to understand animal life and evolution. It is in the pauses of the struggle that we see the superfluity of energy and the exuberance of vitality that seem to characterise wild life. The survivors have had strength to meet the shocks that time and chance have brought. In the quiet interspaces they have more than the beggarly minimum of vigour required. I have dwelt upon this question at some length because unless we realise how important a part these recurrent crises play, it is impossible to understand one of the most marked tendencies in the evolution of civilised man.

Before we dismiss the subject for the present, there is something more to be said. Natural Selection can lead only to a bare superiority to the environment, to the environment in its harshest phase, when, that is, a severe crisis occurs. But sexual selection can confer something more than such a bare superiority. It can form within a species a kind of aristocracy, fitted, by their advance beyond the minimum of strength or adaptation required by the environment, to meet new conditions of a stringency hitherto unknown. To this subject I shall have to return in the chapter on sexual selection. Sexual selection

II

CONSTANCY OF APPARENTLY USELESS CHARACTERS INDEPENDENTLY OF NATURAL SELECTION

If severe crises, weeding out the unfit, recur at intervals short or long, it might be thought that each organism down to its minutest detail would be a mass of adaptation, and that it would at least be possible to make a plausible suggestion as to the utility of every peculiarity. This is by no means the case and some Darwinians have wavered in their faith through the uselessness, as it seemed to them, of specific characters generally. I will take a few typical examples and then say what I can by Examples

way of explanation of the difficulty. The three commonest buttercups in our grass meadows are *Ranunculus bulbosus*, the early one with the bulbous root, *R. repens* and *R. acris*. When the flower of *R. bulbosus* opens, the sepals bend backward and downward, and close round the stalk, in the other two species they lie immediately underneath the spreading petals. It is very difficult to feel sure what purpose, if any, they serve in either *position. They may possibly in both cases afford some protection against the visits of undesirable insects that crawl up the* flower stem. Let us admit this, then, and proceed to the next point. The flower stalks of *R. acris* are round and have no grooves; those of the other two are grooved. The grooving, however, is different in the two species. *R. bulbosus* has five comparatively deep furrows in the stem between the flower and the imperfect leaf below it, so that in transverse section there are five projecting pillars. But two of the furrows have minor ridges running down them, and the latter are sometimes so clearly marked that a transverse section presents a most irregular pentagon. *R. repens* has five well-marked ridges without the two smaller additional ones. The grooving seems to be of no service, and even if we assume that it is, how did Natural Selection make the two forms of grooving constant specific characters when persumably one was as good as the other?

No use can be suggested for the callosities on the legs of horses. The wonderful adaptation found in woodpeckers—in the feet, tail, and more particularly in the tongue and connected parts—are common to the various species. The specific distinctions, mainly founded on coloration of plumage are, it is maintained, of no service. Even genera and families are in many cases separated by characters for which it is often difficult to claim utility. The head of the flower-stalk of the thistle (*Carduus*) on which the little florets grow is covered with bristles. Onopordon, a nearly allied genus, is distinguished by the absence of such bristles. Two other genera of composite flowers, *Hypochæris* and *Leontodon*, are separated from one another for the same reason. You can know the crocodile of the Nile by a tooth in the lower jaw, which, when the mouth is closed, is

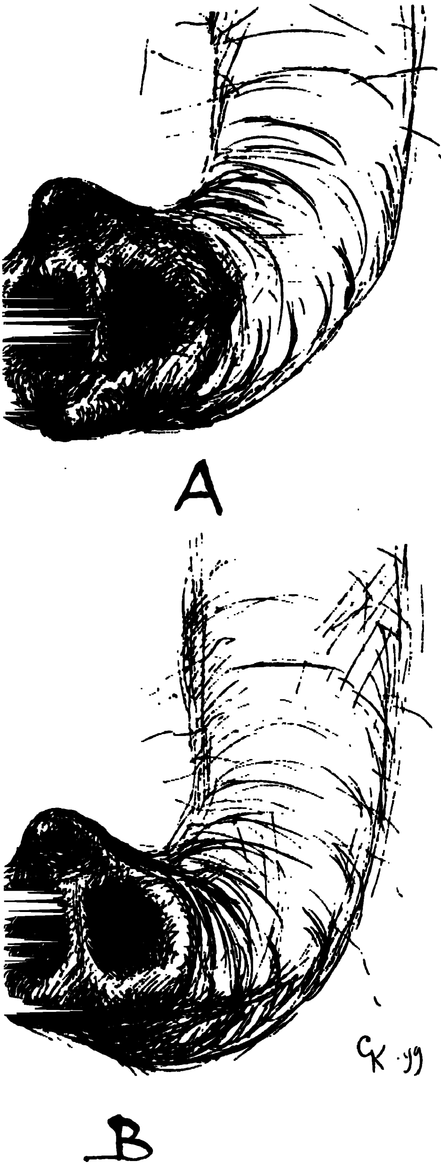


FIG. 10.—Tip of trunk of (A) African (B) Indian elephant.

visible outside the upper. The sea-bears and sea-lions (*Otariidæ*) have an external ear, whereas the Phocidæ or true seals, which probably hear equally well, have none, but merely an aperture. *The new world monkeys may be known from* those of the old by the breadth of space between the two nostrils, and by a difference in dentition, the former having thirty-six the latter only thirty-two teeth. The trunk of the Indian elephant terminates differently from that of its African relative. This is one of the marks by which we can distinguish them easily, but for picking things up one trunk seems every whit as good as the other.

This may strike the reader as a dull list of dull, uninteresting minutiæ. If, however, he will search for more of the kind himself and ponder upon them, they will cease to be dull. For he will come to see that on the verdict of

the scientific world upon them great things depend. I do not myself believe these phenomena seriously menace the theory of the origin of species through Natural Selection. Even in the *present state of our knowledge they may be to a great extent explained, and we may hope that they will become still less formidable as investigation progresses.*

They may be (1) vestiges

(1) Some of these characters are mere vestiges, useful once, but which have been reduced to very small dimensions because they had ceased to be useful. Such are the scales between florets: no doubt, they were once bracts. In *Hypochæris* they linger on, in *Leontodon* they have completely disappeared. If we could only trace back the line of descent step by step, many features that are now too small to help or to hinder might be found to have been once the sheet anchors of their species. In every case, it must be noticed, they are at least harmless; at any rate, they do not prevent the species from living and thriving.

or (2) due to correlation

(2) The principle of correlated variation may here help us a great deal. Correlation, like Mesopotamia, is a blessed word: the evolutionist calls it to his aid when in dire distress. Here it may be of real assistance.

Different parts in an organism are often closely related. If a child has long hands, we prophesy that he will be tall. Great size of head in the offspring must mean largeness of pelvis in the mother. Very abnormal development of teeth in man goes along with a corresponding growth, or else a deficiency, of hair. The interdependence of different parts is shown by the putting out of the tongue during the performance of some act of manual skill, or by the difficulty of moving the left hand horizontally to and fro and at the same time the right hand vertically up and down.

The known examples of correlation are many, though doubtless but a fraction of the number that exist. Did we know them all, we might be able to explain a great deal that is as yet inexplicable. For instance, the dark-skinned races are better adapted to hot climates than the light-skinned, and it is held by some authorities that it is not the dark pigment that confers this

advantage, but some character which is never found apart from it. May not correlation, too, have lengthened the forelegs of the giraffe at the same time that the neck elongated? May it not help to settle other difficult questions of co-adaptation? It *must be owned, though, that it sometimes may put the drag on evolution. Suppose that in birds a long neck was once corre*lated with long legs, and that a particular bird required, as a swan does, a long neck and short legs. But even the tie of correlation may sometimes be snapped. If breeders chose, they might possibly produce a breed of pigeons in which short beaks were not associated with short feet.

Meanwhile we may hold that correlation may *possibly* account even for the varieties of grooving or for the non-grooving of the stalks of buttercups.

(3) We must now consider the bearing of isolation on this question. In a later chapter I shall try to show that without isolation favourable variations would be swamped by intercrossing, and that the building up of species could not proceed. Here I must very briefly anticipate part of what I have to say there. Suppose that some members of a species develop some harmless peculiarity, and suppose that these by transference to a secluded valley or by other means become isolated, this peculiarity will be likely to survive. Inter-sterility with the parent species might soon arise, so that the off-shoot species would be able to leave its seclusion and share the habitat of the parent species without intercrossing. Once given the isolation, due to geographical separation or intersterility or whatever cause, it is quite intelligible that distinctive characters should appear. What calls for explanation is not the existence but the constancy of a small feature which cannot be called an adaptation, and therefore cannot be maintained by natural selection. Such features may, as I have said, be maintained by correlation far oftener than we suspect. But the appeal to ignorance is a dangerous argument to use often. I think it is safer to take this line: nearly all the points in question are comparatively insignificant: in such trifling points isolation unaided seems able to produce constancy, though there are no doubt slight variations in them which escape our notice as

or (3) due to isolation

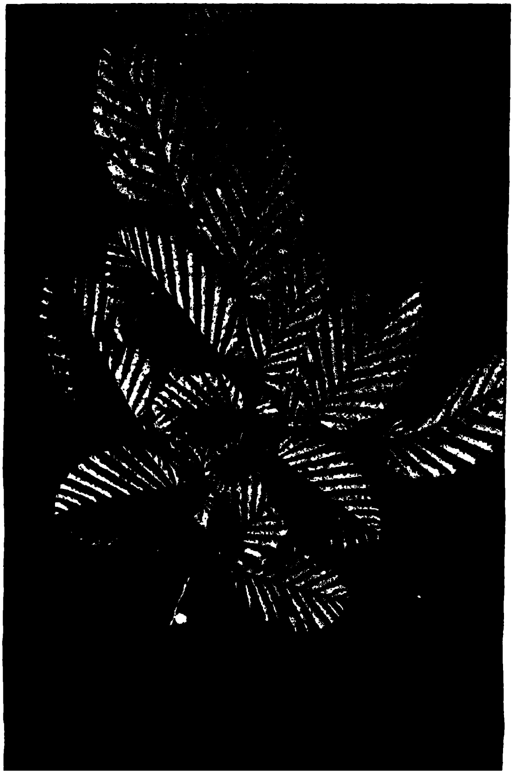
a rule: *if it were a matter of vital need to the species, advantage might be taken of these variations, and we should see an adaptation.* In this connection we may recall the willows, the brambles and the dog-roses and the many problems they present. In the Flora of Herefordshire we find thirty-one species of brier (*Rubus*), besides many varieties. I believe that these and also the many species (or they may be, more properly, mere varieties) of willow and dog-rose are passing through a period of variation during which they present a number of points from which natural selection may some day single out one or two as serviceable under circumstances that have happened to arise. Most of them are very trifling points that cause the utmost perplexity to the systematist. To prove this I need only tell the story how a very competent botanist in his long solitary rambles elaborated a practical joke: he cut two specimens from the same brier and sent one, and then, after a week's interval, the other, to a professor of botany who was, perhaps, the greatest living authority on the *Rubi*. In this case, however, the oracle was at fault, for it assigned them to two different species.

The chaotic state of the brambles is, probably, largely due to intercrossing. We may look upon many of the so-called species as mere varieties, that have not become separated from one another by inter-sterility. The fact that the differences have not become more marked may be due to want of isolation and consequent intercrossing. If we could take forty varieties and put them each on a separate island, it is probable that the distinction would become more noticeable and definite, even though they never assumed an adaptive character. A feature common to all the individuals separated off in a particular island would tend to be accentuated and, if it happened to be harmless, natural selection would leave it unmolested. It is to such isolation that I attribute the enormous number of species representing one family of molluscs in the Sandwich Islands.[1] There has been through isolation a stereotyping of what were before mere shifting varieties. In the same way the small lady-

[1] In the chapter on isolation I shall return to the subject of these molluscs. See p. 177.

birds (*Coccinella decempunctata*), whose coloration varies so much, might, we may hold, be formed into definite groups *either by isolation or by natural selection.*

(4) When once definite species have been formed, separated from each other by inter-sterility, the importance of recognition or (4) useful as recognition marks



ormed by leaves of horn-beam (*carpinus*).
From a photograph.

arks as a means of preventing barren unions between representa-
ves of different groups, is difficult to over-estimate. If we bear
is in mind we shall cease to consider the characteristic plumage
f the various species of woodpecker as useless and unaccountable.

What seemed useless often proves to be an adaptation

On the subject of apparently useless characters Dr Russell Wallace has in his *Darwinism* brought to bear a forcible argument that is constantly becoming still more forcible. One character after another that was thought to serve no purpose is being found to be adaptive. Much has been done in this direction since Dr Wallace published his *Darwinism*. Notably I may mention that Sir John Lubbock has shown that the arrangement of leaves is not haphazard, but is the best calculated for gaining the maximum of sunlight. Sometimes, in the maple (*Acer campestre*) for instance, we find the leaf stalk varying in length, so that each leaf may find an opening and not be shaded by its neighbours. Often the size to which a leaf grows depends upon the space available; each fits into its place and helps to form a mosaic; sunlight is not a thing to be allowed to run to waste. The beech (*Fagus silvatica*) and horn-beam (*Carpinus betulus*) afford good examples of such mosaics. Quite recently Karl Groos has made it clear that the play of animals is not due to mere surplus energy, but that it has a definite use, and that no account of evolution that excludes the subject of play can be considered complete. Mr Benjamin Kidd has shown that religion is not a thing apart, but that human evolution, but for it, would long ago have been brought to a standstill. It is no wonder if some evolutionists come to the conclusion that every structure and quality of every organism will eventually turn out to be adaptive. Nevertheless, he is a sanguine man who retains this view when he fixes his thoughts on some of the familiar minute but constant specific distinctions.

III

VARIATIONS SMALL OR LARGE

Both small and large important to evolution

The variations which Natural Selection finds ready to its hand, and which it takes advantage of to make species, are most of them quite small, but some of them are large or, as they are called, discontinuous.[1] As to the former we have to show that they

[1] I shall use the simple word *large* by preference, as Mr Bateson has associated the term "discontinuous" with a disbelief in evolution by Natural Selection.

are large enough for Natural Selection to take notice of; as to the latter, we have to prove that though they appear in isolated cases, sporadically here and there, yet they are not swamped by inter-crossing. Taking the large variations first, we find many examples of a sire or dam having a strong prepotency so that a marked characteristic, though found in one parent only, reappears unreduced in the offspring.

I have a fan-tail pigeon which has paired with a homer. Many of the young have little trace of the fan-tail about them, but in colour and contour of plumage follow the mother. In some cases, when a white traveller has had children by a woman of colour, his descendants of several generations have reproduced his characteristics, though there has been no second recourse to a white strain. "In 1791, a ram lamb was born in Massachusetts, having short crooked legs and a long tail like a turn-spit dog. From this one lamb the *otter* or *ancon* semi-monstrous breed was raised; as these sheep could not leap over the fences, it was thought that they would be valuable; but they have been supplanted by merinos and thus exterminated. These sheep are remarkable for transmitting their character so truly that Colonel Humphreys never heard of but one questionable case of an ancon ram and ewe not producing ancon offspring. When they are crossed with other breeds, *the offspring, with rare exceptions, perfectly resemble either parent.*" [1]

Darwin quotes also the case of the birth of a merino ram, "remarkable for its long, smooth, straight and silky wool." From this a number of sheep having the same characteristics were raised. "The first ram and his immediate offspring were of small size, with large heads, long necks, narrow chests and long flanks; but these blemishes were removed by judicious crosses and selection." [2]

It is evident, then, that strikingly large variations appearing in one individual may be perpetuated, and that the aphorism *natura non facit saltum* is not of universal application. It is important to recognise this, since it shortens the time required

[1] Darwin, "Animals and Plants under domestication," vol. i., p. 100.
[2] Darwin, *loc. cit.*, see also *The Penycuik Experiments*, by Prof. J. C. Ewart.

for the evolution of species, and Lord Kelvin doles out the millions of years available with a parsimonious hand. If it be objected that the circumstances are artificial, that breeders upset the ways of nature, the answer is easy; the breeder is a new environment, hence a new kind of variation finds favour, but the question of the maintenance of a large variation through prepotency remains unaffected.

It has been maintained that all production of new species has been due to large variations suddenly appearing. But this can hardly be the case. Among domesticated animals and plants such variations occur, there is reason to believe, more often than in wild nature, but breeders while making use of them when they have occurred have steadily accumulated the small changes through long series of generations. The results are patent. And what has been done by man we cannot doubt that Nature also has done. In some ways she has had the advantage, in other ways she has been at a disadvantage. She has begun at the bottom of the scale and so has had plastic material to work upon: she has had millions of years to elaborate each form. Man has worked upon species that were already highly specialised and whose range of variation was, therefore, limited, and he has had comparatively but a few years for his experiments. On the other hand he has usually sought to produce only one or two characters, the rest he has left as he found them. In the horse he has aimed only at speed or strength; teeth and hoofs he has left as they were. Nature has striven after a combination of characters, a more difficult feat in breeding. But we cannot feel sure that several have been attained in the same period. It is highly probable that Nature has often, so to speak, bred for the *improvement* of some new character and merely for the *maintenance* of others that were well established.

Take as an imaginary instance, a race of vultures that required greater keenness of sight; all enhancement of wing power may have been shelved till this was attained. Supposing that many members of the race through defective sight could not find carrion or arrived only after other scavengers had disposed of it, selection would undoubtedly be on these lines.

When sight had attained high excellence, power of flight might have been further developed. In this respect, then, we may doubt whether Nature has been in a different position from the breeder. One difference, however, is very marked. Our domestic breeds have in some cases along with their "points" developed great delicacy. Nature always maintains health and strength whatever "points" she may have in view.

Importance of small points

It is very easy to under-rate the importance of small things, small points of superiority, small weaknesses and so forth, and yet this is a subject in which we have continued object lessons. Two races are brave beyond dispute, but one will stand a little longer under fire than the other, and it is this little that makes all the difference in the struggle. Two young men are about on a par and seem likely to run neck and neck in the race of life, but an almost imperceptible superiority in one seems to act with cumulative effect and in twenty years, say, he is miles ahead. The flora of some oceanic island may seem to show every sign of vigour, but continental plants come in and gradually oust it. The plants of the high Alps will, many of them, grow well at low levels, for they thrive in English gardens. But in the Swiss valleys below their favourite habitat they would have to compete with other plants that in those situations have some slight superiority. The gamekeeper makes war upon magpies and jays impartially. The magpies he often exterminates; of the jays—perhaps they are better at taking cover—some remnant is always left. When a new field is opened for living organisms to settle upon, then the smallest differences tell. When a glacier stream has swept over a Swiss valley and made it an expanse of bare stones, then there is a rush of many plants for the vacant space, and the victory is to those who (to make a bull) know how to find soil where there is none. Such circumstances bring out unnoticed points of superiority. The details of adaptation (like Shakespeare's minor characters) are worked out with astonishing nicety and excellence. Burs are equipped with tiny hooklets, without which they would be utterly inefficient. If in a bird's flight feathers you examine all the machinery for the interlocking of the webs, you find it perfect and admirable down to

the minute barbicels. When we think we understand any particular case of adaptation perfectly, I believe it often happens that some small point has passed unnoticed, which small point, nevertheless, is the finishing touch that perfects the work of art. Here as in so many situations of life, Robert Browning's couplet, that made Tennyson envious, may be appropriately quoted:

> "Oh! the little more and how much it is!
> And the little less and what worlds away!"

Mr Herbert Spencer's failure to appreciate their importance

A failure to appreciate this fact has led Mr Herbert Spencer to find a purely imaginary difficulty, or at least to make a mountain out of a mole-hill. He has called attention to the difference in the power of discrimination possessed by the human skin in different places. An accurate measurement of these differences has been obtained by applying needle-points, held at various distances, to this and that part. When there was but the slightest distance between the points, the tongue was sensitive to each separately; when the back was so tested there was only one blurred sensation, but when the interspaces were considerably increased then there too each individual point was distinctly felt.

How has this difference in sensitiveness arisen? On Lamarckian principles, replies Mr Herbert Spencer. The tongue is constantly exercised in the work of subtle discrimination and its acquired sensitiveness is transmitted to the next generation. As to Natural Selection, we cannot imagine, he says, a man being selected and surviving because of a slightly superior sensitiveness in his tongue.

Here we see failure to appraise small things at their proper value. In this case we may assume that the tactile sensitiveness goes along with subtlety of palate. They are both forms of nerve-power and their office is a most important one: they enable their possessor in many cases to distinguish poisonous from wholesome food. Knowledge as to what is good to eat and what is not, had to be learnt, before the days of chemical analysis, by experiment, and sensation in the region of the tongue and palate enabled the experimenter to reject a great

many unpromising articles of diet, without resorting to the ultimate test. Sir Joseph Hooker describes the tortures that he found the members of a savage tribe undergoing when their ordinary food supply had failed. They had been making experiments on various roots, and frightful pangs of indigestion had resulted. If they had not had their tongues and palates to guide them, matters might have been even worse. Moreover, by the help of taste and sensitiveness of tongue, they would be able to recognise the roots that had caused them such excruciating agony and to avoid them for the future.

Besides this Mr Herbert Spencer has measured the comparative sensitiveness of the various parts at the wrong period of life; has measured them after the attainment of maturity when use and disuse have long continued and have had time to widen congenital differences. The measurements, to be really of value, should be made at birth.

It remains to be said that he has stated the case for Natural Selection very unfairly. No part of an organism is isolated, as he apparently conceives of it. An animal that can develop great tactile sensitiveness in the tongue will be able to develop it at other places also when it is needed, *e.g.* in the tips of the fingers. And who will deny that such sensitiveness, brought to perfection at the various points at which he probes and tests his environment, is likely to do him yeoman's service in the struggle for existence, and prove that it has selection-value?

IV

RETROGRESSION

Importance of shedding what is no longer useful

The evolution of new characters must be accompanied by the shedding of old, otherwise the complex animal would be overburdened by an accumulation of out-of-date organs. To drop what is useless or harmful is as important as to add new features to meet the fresh demands of the environment. It is very natural to complain that the embryo stages only very roughly

recapitulate the history of the race, and that many chapters are missing. But it is most essential to the species, which, after all, is more important than the evolutionist, that the ontogeny should be brief. When once a higher level has been attained by the species, the individual organism cannot afford to rest long on the base degrees by which the ascent was made. Still less can it afford to carry about with it all the primitive machinery of the past. How would it be for man if, in spite of the acquisition of lungs, he retained the gills by which his progenitors breathed long ago? In any organism there is good reason to believe that all the important features are adaptations: they are part of the equipment by which it maintains itself in a world of combat and competition. And the fact that adaptation is the rule is a proof that there has been a perpetual shedding of machinery for which other and better has been substituted.

While, however, it is easy to realise the importance of the general principle, it is not always easy to explain the process. We may distinguish three cases: (1) Where the structures lost are harmful, in that they render the organism liable to capture, wounds or disease; (2) where they are harmful, because their maintenance taxes the vital force; (3) where, though superfluous, they are not injurious.

Retrogression due to (1) Natural Selection

In the first case the loss admits of a very simple explanation: structures that are injurious will be weeded out by Natural Selection. But simple as the explanation is, I shall quote one or two familiar examples to show what an important part retrogression plays in evolution. Many of the crustaceans pass through a free swimming Nauplius stage, the normal sequel to which is some such form as the shrimp or water-flea. But where the species has adopted a sedentary form of life, all the promise of the embryo is falsified.

Sacculina is an extreme instance. It is in appearance a huge tumour on the abdomen of its host, the hermit crab. It sends out a number of filaments which penetrate the whole body of its victim and extract nourishment from it. So completely lost is the crustacean form that there is no trace of segmentation, no

limbs or swimmerets, no mouth and no anus. As Professor Ray Lankester puts it, the creature is "a mere sac filled with eggs, and absorbing nourishment from the juices of its host by root-like processes."[1] Any of the many types of free-swimming crustaceans would in such a situation be out of place.

The barnacle is a familiar example of degradation. It too begins life as a Nauplius swimming freely in the ocean. But on attaining maturity it fixes itself by a long stalk to a ship's bottom

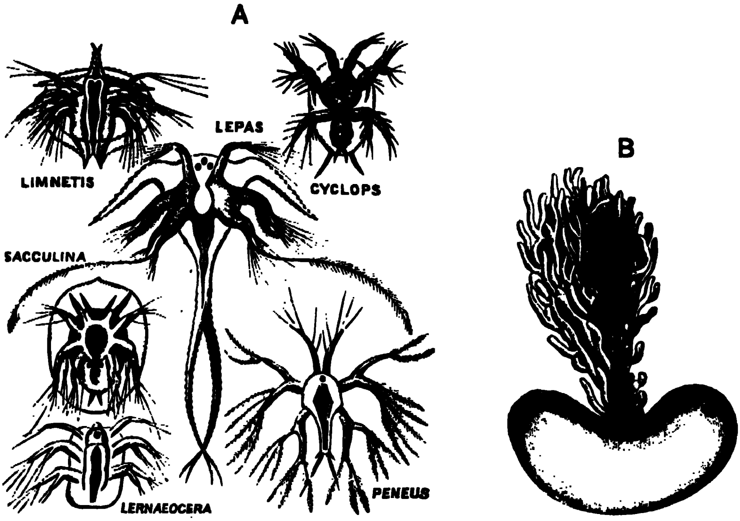


FIG. 12.—(From Ray Lankester's Degeneration.) (A) Nauplius of Sacculina, etc., (B) Sacculina.

or to a pile. Its antennæ disappear; its antennales are found imbedded in the stalk, revealing the fact that it has fixed itself by its head! The eyes and eye-stalks have vanished. Thus it has shed or lost the use of all the delicate sense organs, and has been well compared to "a man standing on his head and kicking his food into his mouth."[2] The stalkless barnacles or "acorn-shells" are familiar objects on rocks on the sea-shore. If they are put in an aquarium they may be seen rythmically opening their bivalved carapaces and protruding their limbs, like their

[1] *Degeneration*, p 34.

[2] Quoted by Prof. Lankester, *Degeneration*, p. 37.

long-stalked kin. Fully developed crustacean appendages would bring these sedentary degenerates into danger.

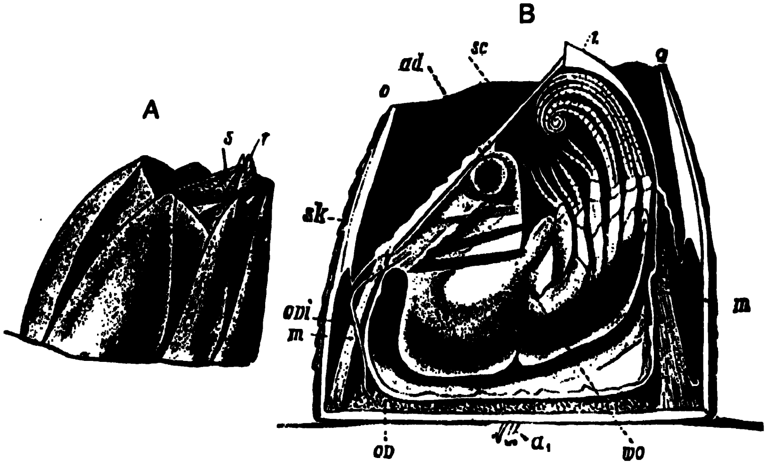


FIG. 13.—*Balanus* or Sessile Barnacle. A, external view; B, anatomy; *a*, antennules; *ad*, adductor muscle; *m*, muscles of scuta and terga; *o*, edge of parapet; *ov*, ovary; *ovi*, oviduct; *sc*, scutum; *sk*, parapet; *t*, tergum; *wo*, female aperture. (From Parker and Haswell's *Biology*, after Darwin.)

Worker ants have lost their wings, and as their business is to forage, collect building materials, and attend the pupæ, we may well believe that it is an advantage to the community that they should be wingless. Wings would encourage wandering aerial habits, which would be out of place in those whose work is on the ground and near at home. The young of many species of birds are born helpless, and remain long helpless in the nest, quite incapable of seeking food for themselves, but waiting open-mouthed for their parents to feed them. Now it cannot be doubted that the young of primitive birds were active from the moment of birth as young lizards and young partridges are now. But the advantage of helplessness is obvious when the nest is placed so that a fall from it would be fatal before the acquisition of the power of flight. We may assume, therefore, that there was a great weeding out of those that were over-restless in their babyhood. Even when the nest is on the ground, it is best that

the young should be helpless, since, if so, they cannot stray or get lost while their parents are collecting supplies.

In the examples chosen the process is clear enough. The conditions have changed, and characters that were formerly useful have become injurious. Natural Selection, therefore, accounts for their disappearance without difficulty.

We now pass on to our second case, where the principle of economy of growth may be called in. (2) to economy of growth

The apteryx or kiwi now possesses mere vestiges of wings, but there is no doubt that he is descended from progenitors in which the fore-limb was fully developed. He is a ground-feeder, and as there are in his habitat, New Zealand, no mammals save bats and rats, nor any formidable reptiles, flight would be a useless accomplishment. But it does not follow that it would involve danger. The habits of the kiwi being what they are, and New Zealand broad and spacious, there would be little danger that storms would carry him out to sea. Thus, whether the kiwis once possessed the power of flight or not, it can hardly be said that the possession of fully-developed fore-limbs would bring any peril with it. Yet their maintenance might cause a reduced flow of nutriment to other parts of the body, where it was much needed.

In the vegetable kingdom, too, there are plenty of examples of the loss of organs, which may have been injurious because of the cost of their maintenance. There is good reason to believe that the grasses are degenerate lilies. In their present state they are wind-fertilised. They have no calyx or corolla; they produce no honey, and are not visited by insects. But the two tiny scales, called lodicules, are, according to the accepted theory, vestiges of a perianth. If so, and there is good reason for holding this view, the grasses once had showy flowers for attracting insects; but, since many plants of a species often clustered together, the wind proved a better fertiliser, and the perianth disappeared. A stop, we may hold, was put to wasteful expenditure.

But before accepting this view, we must clearly define what is meant by wasteful expenditure, since it is not so clear what constitutes waste when we are speaking of a species and not an

individual. A particular apteryx is born with a limited amount of vital energy, and since he makes great use of his legs, this will, no doubt, stream towards them, while other less important organs will be impoverished. Can we say that in the case of a species there is any such limitation? When we speak of economy of growth in a species or breed, I believe that what is meant resolves itself into nothing more than this, *that the difficulty of forming a new breed is proportioned to the number of characters that are required in combination.* Kiwis, possessed of great strength of leg and keenness of scent, were a more probable achievement of evolution, so to put it, when strength of wing, combined with these other qualities, was no longer insisted on.

If I am right in holding that there is for a species no such thing, strictly speaking, as economy of growth, then all the examples of loss that might appear to fall under (2) are really to be ranked under (3) as illustrating the shedding of things useless though not injurious.

(3) to pammixis

There are instances not a few of organs disappearing, though they were so small that we can hardly suppose them capable of bringing the organism into danger, or of taxing its resources. In some whales no traces of hind-limbs have been found, though Mr Beddard is of opinion that they may exist in all. The clavicle, at any rate, seems to have disappeared entirely. "The white whale, *Beluga*, and the Narwhal, *Monodon*, appear never to possess any hairs, either as adults or fœtuses."[1] Not a sign of the upper incisor teeth of ruminants is to be found, even in embryos. Having first dwindled to insignificance, and become incapable either of good or harm, they have finally vanished and left not a wrack behind. In anophthalmus, the blind beetle of the Kentucky caves, the whole machinery of sight has disappeared from the optic lobes to the facets of the outer surface. In the celebrated blind cray-fish (*Cambarus pellucidus*), found in the same caves, the optic lobes and the optic nerves persist: the retina has degenerated. Vestiges are phenomena so common that we may well hold that reduction in size proceeds more slowly when the organ in question has already sunk to very minute dimensions.

[1] See Mr Beddard's *Book of Whales*, pp. 24, 27, and 99.

But the point on which I wish now to lay stress is, that in some cases it does not persist as an insignificant remnant, but disappears completely. Here, at anyrate, economy of growth cannot help us, and we seem driven to attribute the disappearance of the last remnant to what Weismann has called "pammixis" (I spell the word after the improved fashion now followed, since the barbarous word panmixia offended some pedantic zoologists, and prevented them from giving the hypothesis a fair consideration). Pammixis means simply free intercrossing. Weismann assumes that in every species the predominant tendency is towards reversion, and that it is only checked by rigorous Natural Selection. Professor Lloyd Morgan, in discussing the question, starts with a different assumption. "Let us suppose," he says, "that nine individuals are born, and that the size of some organ varies in these from one, the most efficient, to nine, the least efficient. The birth mean will, therefore, be as shown on the left hand side of the following table, at the level of number five, four being more efficient, four less efficient. But if, of these nine, six be eliminated, then the mean of the survivals will be as shown on the right hand side of the table.

1
2 —survival mean
3
4
birth mean—5
6
7 —eliminated individuals
8
9

The result, then, of the cessation of selection will be to reduce the survival mean to the birth mean."[1] "But unless *this be accompanied by a tendency to diminution due to economy of growth or some other cause*,[2] this cannot produce any reduction."[3] This seems to me like a begging of the question. What we have to

[1] *Animal Life and Intelligence*, p. 172. [2] Italics mine. [3] *Loc. cit.*

decide is whether there is an inherent tendency to diminution. Highly as I estimate Professor Llyod Morgan's services to science, I cannot think that he has helped to clear up the question of pammixis.

Most biologists are unwilling to admit that the predominant tendency is towards reversion. They prefer to assume that apart from Natural Selection retrogression is as much out of the question as the evolution of more complex forms. The favourable variations, they say, balance the unfavourable. Assuming this, it follows on mathematical principles that a cessation of Natural Selection will lead only to a decline from the survival to the birth mean.

In the chapter on Heredity and Variation I have argued that variability must inevitably result from the process of multiplication by fission and that the strength of heredity is due to Natural Selection. I picture to myself a species as struggling to ascend an inclined plane: the majority of the component units slipping back, some few only advancing upward, so that only by the aid of stringent selection can the species keep up to the level attained by the successful in the last generation, only by the aid of increased stringency can it climb higher.

The maintenance of stability

It may be difficult to believe that an enormous amount of elimination can go on without producing further evolution. Yet this would seem to be the fact *when there is no change in the conditions*. When the environment changes for a species, any individuals that happen to have adaptive variations are singled out for survival. A new standard is set up and *those that survive are already up to it*. More than a bare superiority to conditions Natural Selection is powerless to bring about, for the species as a body, though, through variations, occasional individuals may rise somewhat above this level. But among the offspring of those selected when the new standard is set up, will be many that fall much below it. The new characteristics will not be constant at first, and Natural Selection will be busy producing fixity, or checking the tendency towards reversion, the tendency to fail to recapitulate the final stages of the phylogeny, to lose suddenly structures that have taken ages to build up. Every-

where there is rigorous elimination to check the backward flow. Even among the spermatozoa there is keen competition and consequent weeding out of the unfit, and to this perhaps we may attribute the fact that pammixis does not work with greater rapidity.

Though I attribute stability as a general rule to selection, I am quite aware that a new character is sometimes constant from the first. But such a thing is exceptional. If we refer to the experience of breeders we find that constancy is due, as a rule, to systematic selection. And wild nature must be subject to the same law. When individuals belonging to a wild species have by the aid of some marked variation survived a change of environment and become the founders of a new species, they are to some extent in the position of a domestic breed in which some particular point has been recently accentuated by selection. Under the circumstances, great stability is not to be expected till some generations have passed and the tendency to retrogression has been checked.

As to the tendency among domestic animals, the testimony of breeders is emphatic. Mr Baker, quoted by Darwin,[1] thus sums up, "Whenever there has been neglect, the breed (of horses) has proportionately deteriorated." Darwin adds what may seem like a qualification of this. "From what we see of the many common races of dogs, cattle, fowls, pigeons, etc., which without any particular care have long retained nearly the same character, we have no grounds for believing that they would altogether depart from their type."[2] He admits, however, that they would be "very far from excellent of their kind," *i.e.*, as I understand it, they would rapidly—after a score or a hundred generations is Darwin's estimate—lose their most recently acquired characters.

I cannot help thinking that Darwin greatly underestimated the tendency to retrogression. Surely there is a good deal of unmethodical selection in the cases where the fixity, the very slow deterioration of which he speaks, is observable. There is plenty of evidence to show that stability, once it has been lost,

[1] *Animals and Plants under Domestication*, vol. ii. p. 239. [2] *Loc. cit.*

is not easy to recover. "In 1793 some wild Scotch roses (*R. spinosissima*) were transplanted into a garden; and one of these bore flowers slightly tinged with red, from which a plant was raised with semi-monstrous flowers, also tinged with red; seedlings from this flower were semi-double, and by continued selection, in about nine or ten years, eight sub-varieties were raised. In the course of less than twenty years these double Scotch roses had so much increased in number and kind that twenty-six well marked varieties, classed in eight sections, were described by Mr Sabine. In 1841 it is said that three hundred varieties could be procured in the nursery gardens near Glasgow." [1]

As with plants, so with animals, though in a less degree. Domesticated breeds have to some extent lost their stability; change of condition stimulates variation; in many cases their characteristics are due to recent variations; sometimes the breed is the result of a cross, after which there is generally a tendency to revert. In fact, when an organism varies it is a proof of variability, and the tendency can only be kept down by rigorous elimination. It is the characters that have become useless through change of circumstances that are noted for their instability. In Dorking fowls the colour of the plumage [2] and the form of the comb have not been attended to; hence has arisen a variability not found in other species. Plenty more examples might be quoted, but it is needless, as the phenomenon is well known.

There are, however, as shown in a previous section, [3] a number of characters which, though apparently unimportant, yet seldom vary, and whose constancy makes them valuable to the systematist as specific distinctions. It is possible that they may be protected by correlation with some adaptive characters; at any rate, they seem to stand in a class by themselves, never having been important as adaptations.

All the evidence would lead us to believe that Natural Selection is almost always required, except in the case of such minutiæ, to produce stability, and that when stability has been

[1] Darwin: *Animals and Plants under Domestication*, vol. i. p. 367.

[2] *Ibid*, vol. i. p. 270; vol. ii. pp. 259, 317.

[3] See p. 77.

attained, it may be lost through a slackening of Natural Selection, and still more through a total cessation of it. But we are trying to find proof that a cessation of selection may lead to something more than instability; that it may lead to the large reduction or loss of characters in all the individuals of a race or species.

If pammixis really produces the great results that Weismann attributes to it, we ought to find evidence among our domestic animals. We must be careful, however, to give the principle fair play, and it is certainly not fair to take such a case as that of the brain of domestic ducks and say that since they are not selected for intelligence, as their wild progenitors to a great extent were, their brain ought by now to have been reduced to something very small. What we do find is that in the wild duck (*Anas boscas*) the brain is nearly twice as heavy in *proportion to the body*.[1] But the domestic duck of most breeds is much bigger and heavier than its wild kinsman; the increase has extended even to its wing-bones, though powerful legs, to carry its great bulk, are the special features developed.[2] In those breeds in which the weight of the body is more than double that of the wild mallard, it cannot be said that there has been absolute reduction of brain, if it is found that its *relative* weight has been reduced to half. The brain has not increased as the body has increased; that is all. This would certainly be a defeat for pammixis if absolute pammixis had been at work. But there has been nothing more than a slackening of Natural Selection, not a total cessation of it. There is no harm in a domestic duck being an imbecile compared with her wild kinsfolk, but absolute idiocy would be fatal. She could not recognise the call of the farmer's wife at feeding time, could not forage for herself as tame ducks are still bound to do. It might be thought that her wings would have become mere vestiges since it is much better that she should be quite incapable of flight. But the flight muscles form the meat on the breast; a deficiency there would

[1] See Lloyd Morgan's *Animal Life and Intelligence*, p. 171. He quotes Sir J. Crichton Browne.

[2] Darwin: *Animals and Plants under Domestication*, vol. i. p. 285.

certainly have been checked by artificial selection, and the extremities of the wing, both the bones and the feathers, have no doubt been preserved by correlation. We may fairly argue, however, that if a slackening of selection can produce some decline from a high standard, then a total cessation would produce much greater results. If domestic ducks are *comparatively* imbecile, it is due to a *partial* application of pammixis. The unrestricted working of it, therefore, would be likely to produce complete idiocy. The same argument would hold with regard to the health of domesticated breeds. There is reason to believe their health has to some extent deteriorated. Certainly domesticated pigeons suffer from a variety of diseases. Horses no less. High breeding and delicacy of health are often found to go together. And yet the breeder does not disregard the question of health, he only considers it as secondary. So that here too there is decreased stringency of selection, producing appreciable results.

We look in vain among domestic breeds for a case in which pammixis has had free play. If an organ has no use in the artificial environment, the breeder has either protected it (if correlation left it undefended) or has hastened its disappearance by selection. The most instructive fact is, I think, the ease with which hornless breeds of cattle and sheep and goats have been formed. The horns of milch cows show the variability that absence of selection causes. Where there is instability,

Sudden and complete loss

there are likely to be instances of *sudden and complete disappearance of the organ.* Now, the hornless breeds have been formed by selection of such monstrosities.[1] In the absence of selection no doubt intercrossing would have made the results less startling. But it is probable a race having horns of very variable (usually small) dimensions might have arisen independently of selection and within a comparatively short space of time. In the course of a score or two of generations the organ might have come to be *normally* a mere vestige.

[1] Dr E. A. Saunders has recently told me of an Aylesbury duck seen by him, between the toes of which there was absolutely no webbing. Apparently in this case there was no variability in the breed preceding the complete loss in this individual

The sudden loss of horns brings out a point to which, I think, attention has never been directed in discussions on pammixis. The evolution of new characters is a gradual process requiring ages of time. Geology shows that the stag's antlers have grown step by step from small beginnings. But they might be completely lost in a single generation. The horns of cattle, though less magnificent, are none the less the slow product of ages of unintermitted selection. But by a sudden freak they disappear utterly in an individual here and there, or leave only a dangling vestige attached to the skin.

Those evolutionists who love symmetrical theories, mapped out regardless of observed facts, imagine a process of retrogression by which all the stages in the evolution of the most complex animals may be retraced in ordered succession. What actually happens is usually very different. An elaborate organ is suddenly much reduced and mutilated or suddenly disappears altogether. The wing of the apteryx has not become by reversion a reptile's fore-limb, then the fin of a primitive fish, and after these transformations slowly dwindled. Under the downy feathers is a minute avian wing, not a reptilian fore-limb or a fin: the machinery of flight has been simply reduced, and, probably not by slow degrees, reduced almost to the vanishing point, so that loss rather than reversion is the word to describe what has happened. No ancestor of the apteryx had a fore-limb similar to the vestige that survives in the present representative of the line. We have here the result of a tendency that is, I believe, universal in the organic world, of heredity tending to fail and let the complex organism that evolution has built up suffer dismemberment. But when through such failure an incomplete or distorted form arises, Natural Selection usually makes short work of it, and we thrust it from our notice as a thing of no importance. If, however, it is not wiped out, the disease, so to speak, may spread to the whole species.

First, the incompleteness shows itself sporadically in a few individuals, and reversion, a tendency always at work, very probably replaces the lost structure in the offspring. Yet these, though they may seem sound and perfect as a bell, are

not trustworthy as transmitters of race-character since they are sprung from an imperfect stock, and *their* offspring may revert to their grandsire. Suppose that such reversion takes place and that a fourth generation is born from this defective third generation, reversion is less likely to save the fourth from taint since the great grandsire was unsound no less than the sire. Reversion, in fact, is a thorough time-server, always ready to change sides. In no long time the whole race will become honeycombed, and what was a rare abnormality will become normal. This is bound to follow, if we accept what must, I believe, be recognised as facts: first, that heredity is always tending to fail, and requires constantly to be maintained by Natural Selection; secondly, that not only reversion to comparatively recent forms but loss, complete or almost complete, of organs or faculties is not uncommon. If this is so, pammixis is great and formidable. It is true that it cannot, like Natural Selection, work cumulatively, *adding loss to loss, as Natural Selection adds gain to gain.* But in one respect pammixis is in a much stronger position. It proceeds by much longer strides; what has taken ages to build up may be lost at one fell stroke. And the tendency to retrogression and loss being, apart from Natural Selection, the dominant tendency, deficiency soon permeates the whole group, when once rigorous elimination has ceased.

The general tendency of evolution

This view is not likely to find favour with those whose optimism leads them to assume that progress is the invariable rule in nature. If considered fairly, however, the conclusion I have come to does not altogether run counter to such an assumption. Natural Selection is as much part of nature as anything else, and as long as it continues to act with undiminished stringency, there is no decline from the level attained. When through change of conditions its stringency is increased, there is further evolution or, if we like to call it so, progress. But I prefer to keep the latter word for advance in civilisation, a thing quite distinct from evolution. Natural Selection, then, not only makes new and higher forms of life possible, but bars the way backward. It is the slackening of competition, a retreat into a quiet backwater of life, that leads to retrogression. This, how-

ever, occurs only in exceptional cases. If, as we are bound to do, we recognise Natural Selection as an integral part of the system at work around us, we must conclude that advance towards higher and more complex forms of life is the predominant tendency. How else can we account for the fact that such forms are found in all the great land areas of the world?

INTER-ACTION OF SPECIES

All species must conform to their environment. If the environment remains unaltered, evolution ceases. For Natural Selection can only give to a species a bare superiority to the conditions under which it lives. The great amount of elimination that goes on even when the conditions remain unaltered, tends, as I have shown in the last section, to give fixity to existing characters. Further evolution can take place only if an environment that is in some way different offers itself, whether the difference consists in the introduction of some novel feature or merely some intensification, some raising of the standard of life in the existing *milieu*.

Comparative unimportance of physical conditions

This being the case, physical conditions are a comparatively unimportant factor. They remain unchanged during long periods. Except in the cases, therefore, in which organisms are transferred from one region to another, their evolution cannot in any large degree be due to the direct action of climate. A race may gradually advance towards the equator and so, as the generations pass, there may by successive steps be evolved a constitution able to stand extremes of heat. But except under such circumstances as these, the influence of climate is mainly indirect. Severe cold may make it more difficult for one species than for another to obtain food. The latter, therefore, will have an advantage in a cold region and will probably oust the former. Two species of grouse may be equally adapted to the physical

conditions that obtain in sandy deserts, but one may be more protectively coloured than another and so may be better able to escape birds of prey.

Evolution of the environment

For every species the environment consists mainly of other species with which it is brought into contact. So that *two evolutions have proceeded side by side, that of the environment and that of the species.* The countless succession of steps by which any complex animal has reached its present stage would be, had not sexual selection come in as a disturbing factor, equal in number to the changes of environment to which each of those steps has been in its turn an adaptation.

Race between competing species

The race between competing species is from the nature of the case a neck-and-neck one, a favourable variation that appears in one must be matched by a corresponding advance in those that are affected by it. If birds of prey grow keener of sight and stronger on the wing, the species that they hunt must improve their means of escape; their quickness on the wing or their protective plumage. If camels devour thorns and leaves of nauseating flavour with relish and voracity, then the plants that trust to such means of defence must become still more thorny or nauseous. When men take to drinking methylated spirit in spite of the abominable smell and taste, it is made still more disgusting, and, to return to the camels, when the plants thus protect themselves, they, in their turn, are bound to develop a still greater contempt for thorns and acrid or bitter juices.

In the history of evolution, as told in the geological record, nothing is more remarkable than the way in which a number of groups move upward, keeping pace with one another. No one largely outstrips the rest. The Silurian rocks tell of fishes but of no vertebrates of higher rank. In the carboniferous period appear a number of Labyrinthodonts, amphibians, some of them with marked affinities to fishes, many of them giants compared with our frogs and newts, running to 7 or 8 feet in length. In Permian times reptiles begin. We have now done with the primary rocks and enter the secondary period where reptiles become dominant. There are many strange forms, great Ichthyosaurians and Plesiosaurians, both frequenters of the sea

where they prey upon fish. But meanwhile a true land fauna is appearing; there are small marsupial mammals and archæopteryx, an indubitable bird though lizard-like. These forms were but crude suggestions of what was to be; they had none of the perfection of mechanism afterwards attained by the groups to which they belonged. Such perfection would have been out of place amid the clumsy creatures with whom they shared the world. Tigers would have played havoc among the ponderous Iguanodons, elephantine reptiles, that appear in cretaceous times. They would have exterminated them and whatever other food supply there was, and would then themselves have starved. A too rapid advance of any one species would have upset the course of evolution. But of such an occurrence there was little danger. For any ground that was gained through lucky variations in individuals could be permanently held, only if there was pressure from competing groups.

With the Iguanodons come in the Pterodactyls, winged reptiles, some small, some big, their wings measuring twenty-five feet from tip to tip, great expanses of membrane suggesting the wings of bats; their hollow bones make it probable that they were warm-blooded. What havoc these winged creatures must have made among Iguanodons, even the armoured forms! The period of quickness in attack and flight now begins on land; there too, mobility is the all-important thing; long ago there had been speed in fish and their pursuers. Now, whether on the ground or in air, there is no safety for the slow. And so at the beginning of the Tertiary period, quickly moving mammals become the dominant type. In spite of their wings the Pterodactyls prove too clumsy—they are clumsy on the ground, and flight alone is not enough—and the feathered flyers, active on their legs and not only on their wings, by gradual steps proceed to the most exquisite adaptations. If the mammals are dominant, birds have a rival kingdom and they are often able to invade the territory of their superiors and prey upon them. Among the mammals we see the striking forms of the monster Mastodon; Dryopithecus, an ally of the chimpanzee, is on the stage, and there is the plainly recognisable ancestor of the horse. These

are in Eocene times, the first of the periods into which the Tertiary is subdivided. With the Pliocene there is another advance. There are the cave lion, the cave bear, the Irish Elk (*Megaceros hibernicus*), and there is Man. All these advances have been made by not very large stages, and each step in every group has necessitated a levelling up in others, or extinction or retirement to some sequestered corner.

Back-waters of life

Aldabra Island which lies north-west from Madagascar is one of the quiet backwaters of life, unaffected by the onward sweep of the main stream, and there the gigantic land-tortoise (*Testudo elephantina*) has found refuge. Australia, for all its size, has not been the scene of the fierce competition that has taken place on continents, and in it, as in a museum, have been preserved very ancient Marsupials. How great the stress of the struggle has been on continents is shown by the fact that the hippopotamus is the only mammal that survives to represent the fauna of the Pliocene period. All the rest have been swept away or, when the standard of life has risen and an age of higher pressure has begun, have proved equal to the call upon them, and have adapted themselves in structure and habit to the new order of things.

Plants

Side by side with the development of animal forms has gone on an upward movement in plant life. First, in the time of the primary rocks, there are tree ferns and gigantic plants allied to club mosses. With the secondary rocks come in conifers. Not till the cretaceous deposits which mark the concluding phase of the secondary period do we find deciduous trees, whose first appearance, therefore, coincides with that of the Pterodactyls, animal and vegetable life advancing together to higher planes. The connection cannot be considered fanciful, for on plants, directly or indirectly, animals depend for their food. The deciduous trees belong to the higher orders of the phanerogams (flowering plants), the characteristics of which are cross-fertilisation, rapid growth and variety of adaptation. Before their advance ferns and club mosses have retreated to dark or hungry corners. The lion's share of the sunlight and the soil is for the modern enterprising phanerogams.

Probably the rate of progress has varied much at different periods. Any change of condition, climatic or other, must have necessitated adaptation. Emergence from the water to the land led to the development of lungs, and the consequent better oxidising of the blood was accompanied by the perfecting of the heart. At the same time appeared the feathers of birds, the hair of mammals, so that the heat generated in the body might not be lost by radiation. One variation trod on the heels of another, the stimulus occasionally coming from changed physical conditions, more often from competing species. It is difficult to stand still in a world of progress. When the butterfly became more protectively coloured, the bird had to improve his eyesight. If one species of vulture increased its range of vision, others must follow suit, or arrive too late at the feast. If bees improved their sight and means of extracting honey, other insects must sharpen their senses, and improve their machinery, or else go hungry. The lion and other beasts of prey increased the speed of the antelopes by catching and eating the slow ones. They themselves too then had to improve in speed or be left panting in vain pursuit. On the other hand it would have been fatal for them to improve over fast, for they would have destroyed the species that supplied their larder, as the Maoris are said to have exterminated the Moa, and as civilised man seems determined to exterminate the African elephant and many of the noblest mammals.

Varying rate of progress

But has this always been going on? Are there not times when an equilibrium among species is attained, when each remains at its level and leaves others with which it comes in contact undisturbed at theirs? Are we not passing through such a period now? It is very difficult to answer such questions. It is so recently that man began to observe accurately and record his observations. Only forty years have passed since the publication of the *Origin of Species* gave purpose and system to the work of naturalists. Allowing for all this, I think we may yet conclude that the present is not a time of rapid change among wild animals. The progress in our domesticated species is a standard of comparison, and it is impossible to deny that at times progress

Times of equilibrium

in wild nature may have been equally rapid. The following argument is one which has weight with me. All the main groups have been long established and their chief characteristics date from pre-historic ages. But there was a time when in the vertebrates the characteristic features were recent attainments, and consequently, if the view of breeders is correct, were more likely to vary; there was a time when in the bird-reptile or reptile-bird feathers were a novelty and the great possibilities that lay in them were only vaguely suggested. This opens the question whether there is a limit to evolution along any particular line, whether, for instance, a swift's wing has been so perfected that no further advance is possible; so that, if there is to be a more perfect living flying-machine, nature must start low down in the scale on another plan and from there work upward. On such a subject we can merely speculate, but for myself, I cannot help believing that in some cases the greatest perfection attainable on the lines followed has been already attained. At any rate we know enough of the methods and of the course of evolution to feel certain that the range of variation for the highest species is limited. It is absurd to demand, as has been demanded, that in order to prove the Darwinian theory, a new kind of animal should be produced by scientific breeding, that the breeder of horses should turn out not merely a new variety of horse but a breed different enough to rank as an entirely new species. If such a thing is possible, it is for nature to prove it, not for man. It would require hundreds of thousands of years, an experiment such as nature alone can make. And it may be that even she in order to produce any striking novelty would have to begin with some more simple form and work laboriously upward.

A possible limit to evolution on particular lines

But for nature as for man, I think it is now impossible to begin low down in the scale of animal life and from that develop some higher form. Even the lower types of life are highly specialised. The Ornithorhyncus, the lowest of mammals, is near to perfection on his own level. The Hydra is little but a stomach and tentacles to catch food for the stomach. True, but the tentacles are marvels of adaptation. The fact is that

the opportunity for each development seems to occur but once in the history of evolution. Primitive mammals appeared when there was a chance for them in the age of mere reptiles and very primitive birds. If birds had been what they are now, the first small mammals would hardly have held their own. To go back to the first beginnings of life, the simplest one-celled creatures, compared with which even an amœba is highly specialised, competed with one another. They developed a contractile vacuole, an imperfect one, or added a cell or two, clumsily attached perhaps, and were in the vanguard of progress. But such old world progressives would have no chance now. In any aquarium there would be twenty animal forms, low yet specialised, ready to assert their superiority. It may be that even now live protoplasm is constantly arising from dead matter. But if so, these new arrivals have no great future before them, for all the good places are occupied, and long established occupants will not tolerate an upstart species that has not even mounted the first rung of the ladder.

Extreme longevity a check to evolution

With some evolutionists, I believe, it is an article of faith that any species, should it not be crushed out of existence by others more richly endowed, has an unlimited vista of possibilities before it, a view that seems to me very difficult to uphold. In the Natural History Museum at South Kensington is a section of a mighty Sequoia from California. At the base it measured 90 feet in girth, and 18 feet from the ground its girth was 50 feet. When cut down in 1892 it was one thousand three hundred and thirty-five years of age, and there is no sign of decay revealed in the section—every ring is perfect. If the monster tree had been allowed to die a natural death, it is difficult to say when its hour would have come. Its extraordinary longevity we must attribute to the struggle for existence and Natural Selection. The species whose members, when once they had found a good site, could hold it for centuries, was in an almost unassailable position. Year after year more gifted rivals might scatter their superior seeds and try for openings for their offspring. No modern contrivances for scattering, for rapid germination and growth, would be of avail against an old-

established Sequoia. But the very success of this remarkable species must have almost put an end to further development, unless accidental causes of death were frequently at work. If Sequoias were allowed to live to the natural term of their existence the seeds scattered in the forest would be many or most of them the sisters of those scattered more than a thousand years ago. *What hope was there, then, of the working of Natural Selection, of the gradual accumulation of small favourable variations? The Sequoias, in fact, conspired to put a stop to evolution* with all its abominable machinery, internecine war and elimination. And they succeeded in putting the drag on, but the coach was not stopped altogether, for on the label beneath the section we read that the Sequoia and the Red-wood are the only surviving members of a genus which was represented in the English flora by several species in Cretaceous and Tertiary times. For some reason or other such long-lived trees were not able to appropriate the whole land area of the earth as their territory. In other regions other trees competed and developed excellencies other than longevity. Thus fortified, when at length a Sequoia succumbed to age or to a great fire, they cut in and established themselves. That for over thirteen hundred years no conflagration occurred to cut short the career of the giant Sequoia seems to point to some peculiarity of situation.

The Sequoia is only the most conspicuous illustration of a tendency. All the species of long-lived plants trust greatly to the fixity and longevity of the individual. It is true that some, such as the horse-chestnut and the lime, have beautiful or sweet-scented flowers such as appeal to insects, and that very many have means of scattering their seeds. But these excellencies we must hold were attained during a previous period of short-lived generations.

Is there among animals any phenomenon at all similar to this attempt, so to speak, by sheer longevity to make further evolution needless for the species? At South Kensington is to be seen a gigantic land-tortoise from Aldabra. Its weight was 870 lbs. When it was killed it was known to be eighty years *old and it was still growing. This I learn from the label.*

There is also to be seen in the museum the restoration of a tortoise, fossil remains of which were found in the Siwalik Hills in India. This representative of the Pliocene period was, without his head and neck, about 8 feet in length; the Aldabra tortoise, with head and neck, measures about 5 feet in length. Probably this ancient form required even more years to grow to his full size, and enjoyed even a longer span of life than the comparatively small modern forms. But, however generous our estimate, how paltry and insignificant is his term of years compared with that of the giant Sequoia! For an animal such longevity is impossible. He cannot, like a tree, fix himself in one place and there find food and all that he requires. He must, unless he is a mere parasite, be constantly on the move. He must not only avoid being eaten but he must compete with others for food. Such a life brings constant perils, and it is probable that few wild animals die a natural death. The mere power to live on, therefore, dependent on these two conditions, that food should be always present and enemies always absent, would be of very little value. These giant tortoises may be said to have tried evolution on such lines so far as it is possible for animals, and the result is that they survive only on a few small islands. From the great arenas of modern life they have disappeared.

Isolation no substitute for Natural Selection.

If, as I have tried to show, each successive step of evolution is due to some change in the environment, and generally to increased fierceness of competition with other species, then it is clear that mere isolation cannot, as Romanes thought, take the place of Natural Selection. It is quite true that Natural Selection is itself a form of isolation. The unfit are eliminated: death parts them from the survivors by the most impassible of barriers. But Natural Selection isolates in an altogether peculiar way. It does not, like all other methods, set certain individuals apart upon an island and leave them there to themselves. It brings about *a succession of isolations on a progressive system.* It alone has been able to accumulate variations and build up all the perfection of the plant and animal worlds. The achievements possible for any other kind of isolation are very small. Supposing members of some species to be put on various islands, on which the

conditions of life were exactly similar, then, if passage from island to island were impossible, we have good reason to believe that differences would arise, and that what might rank as separate species might be formed. But the matter would end with mere diversity, probably representing little more than the stereotyping of the inconstant varieties found within the species before it was distributed among the islands.

But this limitation to the power of isolation must not blind us to its importance. Natural Selection unaided can only raise a species to a higher level, it cannot increase the number of species —*it can account*, as it has been put, *for monotypic, but not for polytypic evolution.* The elimination of the unfit will leave only the fit upon the earth; hence there will be advance but no diversity. If from one species two or more are to be formed, we must imagine that in some individuals a variation arises that adapts them to an alternative environment that is at hand: birds, though members of a grub-eating species, may find themselves possessed of a strong muscular stomach or gizzard, fitting them to some extent for a diet of grain. If these individuals can somehow be kept apart from the rest to prevent intercrossing with its swamping effects, a new species may be formed.

Natural Selection and isolation are mutually dependent. Neither could have done much without the other.

VI

SYSTEM BY WHICH WASTE IS REDUCED

Indiscriminate elimination

The survival of the fittest in the struggle for existence is certainly the principle to which the vigour of animals and plants is due, and is, I believe, the principle on which we must account for evolution. But we cannot expect the whole truth to be summed up completely and exactly in one short phrase. The question obtrudes itself, Are those that are eliminated always the unfit? Do not young oak-trees die by the million every year in England simply for want of room to grow, the most

promising and the least promising crushed out of existence together? Does the dragon-fly larva (*Libellulidæ*), noted as a most aggressive and predacious reprobate, succeed in catching only the less fit tadpoles, or does he suck the blood of the fit and the unfit alike? The cod-fish (*Gadus morrhua*) strews the breeding-grounds with millions of eggs, and a very large proportion of them are devoured before the life in any has begun to stir, before comparative fitness has had time to show itself. Even when the embryos hatch out, they must be preyed upon by enemies with whom the infinitesimal differences between the young individuals count for nothing.

With each species we must remember the one supreme object, so to speak, is the continuance of itself. Life is a trust which each generation must hand on. It is better, therefore, that a pine-tree should wastefully fling its showers of pollen than run any risk of not fertilising the ovules within the cones. It is far better that a horse chestnut tree (*Aesculus hippocastanum*) should produce, year after year, hundreds of seeds in vain, than that it should miss any opportunity of establishing a seedling. Of cod-fish, too, and their prodigality of eggs we may say that any amount of waste is better than the slightest risk of extinction.

And further, it must be remembered that all the destruction even in the cases mentioned is not indiscriminate. Among codlings there are, beyond a doubt, the fit and the unfit: different grades of vigour, of instinct or even, perhaps, of intelligence. After a great deal of indiscriminate slaughter of embryos and small fry comes a time of selective destruction when merit to a great extent makes itself felt. So, no doubt, it is with frogs, even if the trifling superiorities and inferiorities in the tadpole stage count for little; and so it is, when the grand opportunity comes, with seedling plants.

Waste-reducing contrivances among plants

But obviously, if any species could prevent waste, it would have an advantage. Many plants, therefore, have produced the most elaborate contrivances for transferring pollen from flower to flower by some more economical agency than the wind. The services of insects have been enlisted and the world has been beautified with thousands of varieties of flowers which help, all

of them, to put a stop to the wastefulness of the primitive wind-fertilisation. The constant tendency to reduce waste makes itself visible everywhere in nature. It is no use objecting that a comparatively simple flower like a buttercup (*Ranunculus*) is more widely distributed than many orchids that have elaborated the most perfect system of cross fertilisation; that grasses having once had perfect flowers, which very probably appealed to insects, have lost their petals and their calyx, and trust entirely to the wind; that fir trees, for all their waste, thrive and multiply wherever the soil and other conditions are suitable; that cod-fish are caught by the million every year and yet the supply does not fail. All this is true; nevertheless it is not the whole truth, but only a small portion of it.

Every species depends for its survival on a number of characteristics. Many species of fir trees can grow on hill sides where the soil is scanty, sending out long roots over the rocks till at last they come to a patch of good ground. Their needle-like leaves do not allow a great weight of snow to lodge, so they maintain their foliage throughout the year. When once well established they take the moisture out of the ground, shut out the light and allow nothing to grow beneath them. Once established, they remain unassailable, except by fire or by man, for years. Compare this with an orchid. It too has to make good its claim to remain upon the earth. Owing to the shortness of its life, the success of its seedlings is of the utmost importance; its seeds germinate quickly and it finds room for young plants near at hand. It produces a very limited amount of pollen, but succeeds by means of its showy flowers and its nectar as a rule in getting a great number of ovules cross-fertilised. Being very small it takes precautions against being eaten by cattle, and it is, in many cases, I believe, distasteful to them. Its sum total of characters save it from destruction as the fir tree is saved by *its* sum total.

As we should expect it is mainly among herbaceous plants we find the most perfect contrivances to ensure cross-fertilisation. The stability and longevity of the forest tree enables it to dispense with many of the shifts and clever devices to which

small plants resort. *Or it may be that the fact that numbers of a kind often grow together makes the wind an efficient pollen-carrier for them.* This, at any rate, seems to be the case with the grasses. Able to pack close together in little forests they find the wind serves their turn. In one way many big trees make great efforts, so to put it, to prevent waste. They have developed all manner of contrivances to bring about the scattering of their seeds far and wide so that they may not all be stifled under the parent tree. The wind whirls away the fruit of the sycamore (*Acer pseudo-platanus*), the nut-cracker carries off a fir cone to some favourite perch and from there drops an occasional seed, the squirrel now and then drops or forgets his nut. The trees have made elaborate preparations in order to make use even of an occasional chance of portage.

Reduction of waste in animal species

Marvellous as are the contrivances in the vegetable world to prevent waste, they are nothing to what we find among animals. In none of the higher classes is Natural Selection allowed to act in full force upon the young; during youth its incidence is to a great extent indirect; that is, if the parents are strong and the circumstances are favourable, they are able to shield their offspring and surround them with every comfort. Social insects feed and protect their larvæ, but it is among the vertebrates that parental care shows itself most conspicuously. The male stickleback[1] makes a nest and protects the eggs, guarding them even from his own cannibal unmotherly spouse. A queer, isolated phenomenon this. It is only the warm-blooded vertebrates, the birds and mammals, that can be said to fend off Natural Selection from their young. The difficulties are often great. Imagine twelve young tomtits in a nest. The parents are continually dropping grubs into their open mouths. All seem to get their fair share, though how an equal distribution is possible in a dimly-illuminated hole it is difficult to understand. Probably there is something of a struggle in the nest, and the weaker come off not quite so well. Among a litter of domestic pigs there is sometimes one that is jostled from the trough, and is lean and under-sized, which one, before the days

[1] Gasterosteus.

of tithe commutation, was often "the parson's pig." But these are trifling details that must not prevent us from seeing the main fact, that the day of the serious working of Natural Selection is put off. Among birds even the præcoces, which emerge from the shell able to walk, are shielded by their mothers from the cold, have food found for them, are taught what is good to eat and what is not, and are protected from enemies. Only the Megapodes, when the sun has hatched their young for them, take upon them no paternal duties, but leave their offspring to do the best they can for themselves.[1] Among mammals the better system is in full swing, and, difficult as it is to define our meaning when we speak of an animal as high or low in the scale, we may say, at any rate, that the nursing of the young—its comparative completeness and its duration—is a criterion that must not be left out of sight. Looking at it as evolutionists, we see in it a means of preventing indiscriminate elimination. The parents use the surplus energy and means of subsistence that are theirs during the pauses of the struggle for existence to save their young from storm and stress. Or we may put it in this way: the bringing up of their offspring is itself one of the crises which the adult members of the species must be able to meet, or else the species must be exterminated. When once the parents discontinue their fostering care, then begins for the young the unmitigated incidence of Natural Selection. But, by now, small congenital differences, so small that the young nestlings or baby mammals were perhaps indistinguishable, have had time to make themselves appreciable. In the young family some are strong and some are weak, some have one characteristic in a marked degree and some another. One young crow is more cunning, another from the same nest is stronger on the wing. Hence when elimination takes place, it is less indiscriminate than it is among the eggs of the cod or among the infant codlings.

We must not forget that the clever and brave among birds and mammals will succeed in protecting their young far better than the stupid and cowardly. Hence there will be an increase

[1] See Dr F. H. Guillemard's *Cruise of the Marchesa* for an account of the habits of the *Maleo*.

of cleverness and courage. The differences between one fish and another in this respect must be much less marked, but, granting that they exist in a considerable degree, yet, the offspring being left untended, the superiority of a particular parent will not help its brood to survive except in so far as they inherit the superiority. With mammals and birds the offspring of the more vigorous and better endowed have a double advantage: first, they probably inherit their parents' qualities of mind and body; secondly, they receive from their parents a better start in life.

Play and its meaning

During this early period the young mammal, sheltered from the world and its cruel realities, is not merely eating and growing. He is devoted to play, and in his play exercises all his muscles and his faculties. If growth were all that is required, a recurrence of hearty meals at short intervals and no exercise beyond that of eating would be the best thing. But during this period of inactivity much more than mere growth has to take place. The various muscles have to be coadapted, and their activities co-ordinated. Even a steam-engine, that is meant to go through one set programme and no more, often sticks and jars, and is restive till the various parts have learnt to work in harmony together. *À propos* of this, we may recall the caterpillar and his great feat of spinning a cocoon. It is a truly wonderful performance. But there is the beginning and end of his skill. He has no versatility. A lamb, on the other hand, which is not usually counted among the cleverest of animals, has to perfect all his paces, to make an art of his skipping, his high-jumping and broad-jumping. For I am imagining him a member of a wild stock with enemies that he will have to outstrip. Besides this, he must learn what is good to eat and what is not; among his neighbours on the mountain slopes, who are dangerous and who are harmless. The requisite knowledge of the last-mentioned subjects he will get by watching his mother and the rest of the flock, and imitating them. But much that is important to him he will learn by play, the importance of which has been made clear to the world by Karl Groos in his *Play of Animals*. Puppies, kittens, young lions, tigers, leopards,

elephants, monkeys, are all great at play. And in playing they are not merely working off a surplus of energy, but getting their muscles to work in harmony, and at the same time rehearsing in sport the hunting and fighting that will be for them the serious business of life. Karl Groos has very little to say about the play of elephants. But their striplings develop their young intelligences in the same way as the young of other species that are endowed with a good deal of brain power. Up to the age of seven or eight they are devoted to play of a butting, rough-and-tumble style, a little over-rough sometimes for a tender infant, and in his distress he will call loudly for his mother.[1] And does not the spirit of play survive in the sense of humour shown sometimes by the adult elephant? For I must accept some of the stories, Indian and others, told to his credit, though Mr Lockwood Kipling would discredit them and whittle his intelligence down till there is nothing left of it.

Play, then, is an instinct through which the harmonious co-operation of the muscles is brought about and the intelligence is developed. It is a preparation for, and a rehearsal of, the battle of real life. This view must, I think, find general acceptance, since the broad facts are in its favour. Where infancy is a period of play, there we find, in the adult, versatility and intelligence. Where, as in the bee or the caterpillar, the business of life is the only thing thought of, there we find often great skill, but it is of the instinctive stereotyped kind.

One difficulty in the way of the theory I must mention. Young birds in the nest get no play and practically no exercise. Under the circumstances even the most sedate gambols would often be dangerous. When they have the use of their wings they take a delight in exercising them, and those that have been penned up in nests, *e.g.* crows, red-polls (*Acanthis linaria*), parrots, turn out at least as clever as those who have taken walking exercise and hunted for food from the hour they pecked through the shell. But the difficulty is not a very great one. In no birds is intelligence of a high order found.

[1] The play of young elephants has been described to me by Mr Warington Smyth, who has watched them playing in Siam.

They are far behind (I regret to say it of them) the more intelligent mammals. Their cleverness is mainly of the nature of instinct; only to a very limited extent are flight and nest-building acquired accomplishments. The young house-martin (*Chelidon urbica*) plucks up courage, trusts himself to the sea of air and finds with delight that he is able to fly though he has never learnt.

True, this instinctive accomplishment requires perfecting, there must be intelligence working on the instinctive basis. The young swallow, though quite capable of flight from the moment of the first plunge, has to learn by practice all the niceties of muscular co-ordination, all the subtleties of adjustment of his wings to sudden gusts and all the quick turns that are necessary if he is not to let half the gnats escape. He learns a good deal, yet his versatility and intelligence are far below what we find in those mammals whose play is varied and prolonged.

No tending of the young among "water-breathers"

I wish now to discuss parenthetically an interesting question to which the subject in hand draws our attention; why do "water-breathing" animals, those that for respiration make use of the oxygen dissolved in water, all allow the direct and pitiless incidence of Natural Selection upon their young? It is, I believe, because they have never risen to a high enough pitch of vitality to permit the adoption of a better system. The only warm-blooded animals in the sea, such as whales and porpoises, are not, properly speaking, children of the waters, for in order to breathe they rise at intervals to the surface. But if in the true children of the sea and river the pulsation of life is weaker, why is it so? Here the answer is not difficult. The oxygen at their disposal is so limited in amount that their breathing is comparatively ineffective. According to M. Milne Edwards from $\frac{1}{45}$ to $\frac{1}{30}$ of the volume of sea water consists of air, and though as much as 32 or even 39 per cent. of this is oxygen, yet the amount available for a fish to oxidise his blood with is obviously very small. The deficiency of sunlight and the consequent poverty of vegetable life may also be hindrances, but the scarcity of oxygen must rank before them. The whales and

the porpoises derive their food from the water, their oxygen from the air, not trying to wring from the sea what it can only supply in meagre amount. For fish there are not the same possibilities. They may compete with one another as they will, or develop what adaptations are possible for defeating one another in the struggle, yet the prizes attainable by the winners are strictly limited by the physical conditions under which they live. Consequently they have been unable to rise to that high state of physical vigour which must be attained before, through the mitigation of the incidence of Natural Selection upon the young, a further advance is made possible.

I have now shown how the shielding of the young by their parents till they reach maturity, their exercise and their play, help to lessen the waste of indiscriminate elimination. There is another way in which the family system with its various developments forwards the process of evolution, and this will be dealt with under the next heading.

VII

INFLUENCE OF THE INDIVIDUAL ON THE EVOLUTION OF THE RACE

Natural selection using Lamarckian methods

A variation, if it is to forward the process of evolution, must have selection-value in the first individuals in which it appears. A mere rudiment to be some day, when fully developed, useful to far-off descendants, is not a thing that a clear-headed evolutionist can speak of seriously. The fore-limb of the avian-reptilian ancestor of birds must have been serviceable to him as an oar or a wing or as a compound of the two. It cannot have been a reptile fore-limb spoilt and a mere prophecy of a wing. However imperfect, its usefulness must have been in the present, not in the future. When new circumstances arise, there must be, in individuals that are to survive, a fairly complete adaptation ready to hand. The antelopes cannot say to the cheetahs, "Give us a respite of a hundred generations and we shall be able to race you." Somehow the antelope has found a way out

of the difficulty. Evolutionists have not always been so successful in showing how a species is able to stave off an imminent peril and obtain a respite during which a lucky variation may appear to save it. But now Professor Mark Baldwin[1] and Professor Lloyd Morgan[2] have independently arrived at a theory that makes matters much easier. "Though there is no transmission of modifications due to individual plasticity," writes the latter, "yet these *modifications* afford the conditions under which *variations*[3] of like nature are afforded an opportunity of occurring and of making themselves felt in race progress."

The significance of this principle is clearly seen when it is studied in connection with the family system that prevails among the higher classes of animals, which feed and tend their young and to some extent educate them. Among social species it rises to still greater importance. In the light of this new principle the tending of the young by their parents is not *merely* a system by which waste is prevented; it is also a system which prevents a species from deviating widely from the line of development that it has begun to follow.

I shall now try to make clear, mainly by examples, how the principle works. And first I shall try to show its operation when parental affection is not present to bring out its further possibilities. It may be stated thus: *a congenital variation, in itself too minute to affect the question of survival, may gain selection-value through exercise. The variation having thus been saved by exercise, further variations in the same direction may occur.*

The ancestors of the amphibians lived throughout their lives in water, breathing the oxygen dissolved in it by means of gills. Now individuals in whom a rudimentary lung appeared, a pouch opening from the œsophagus, might develop the breathing capacity of this rudiment by coming frequently to the surface and inhaling air, or by getting out on to the bank either to rest or to escape from enemies. Then there might arise a terrible emergency such as comes to many "water breathers," if they live in fresh-water pools; there might be a drought causing the

[1] *American Naturalist*, June and July 1896. [2] *Habit and Instinct*, p. 315.
[3] Italics mine.

pools to dry up. At this crisis some individuals are saved by their lungs. They have so far developed their makeshift pouches by exercise that they are able, though not without strain and discomfort, to become exclusively air-breathers, till at length rain comes or they have made their way to another pool from which the water has not evaporated. If there is a succession of such droughts, there will be a further selection of those who have serviceable lungs. Thus individuals tide over a crisis by improving their natural gifts by exercise; without such Lamarckian methods, they would not be equal to the emergency. At the same time there is a selection of those who can thus improve themselves. When the next drought comes probably further variations in the same direction have arisen, and there would have been no opportunity for this, but for those modifications due to exercise which secured a respite for the species. And thus modifications though not transmitted to the next generation are the prelude to variations similar in tendency to themselves. Before going further, I must say something to justify the above illustration. It is probable that the lung was in origin a fully-developed swim-bladder. But a fully-developed swim-bladder may be only rudimentary when regarded as a lung. There was need of exercise to make it serviceable and give it selection-value in this capacity. I have felt justified, therefore, in speaking of it for the sake of simplicity as a rudimentary lung.

One more instance. Imagine the Wapiti deer, or rather one of his progenitors—this is the old puzzle set to Neo-Darwinians by Mr Herbert Spencer—developing great antlers through the accumulation of congenital variations by Natural Selection. What if the muscles and ligaments of the neck and of all the co-operative machinery did not grow strong through favourable variations during the same period? The answer is plain enough; even without the help of Natural Selection the organism will be able to make shift for a time. Muscles can be strengthened by use during the lifetime of the individual. How much can be done in this way if we begin, say in our teens, and exercise certain muscles regularly for half an hour a day! How great would be the result if we exercised them each day during

the whole time that we were on our legs! All day the stag was carrying his antlers and his muscles were acquiring the strength that was needed. But when the antlers in the course of many generations had grown big, males that were born without specially adapted muscles to carry them, would not be likely to be lords of the herd. So that here too congenital variations would follow in the wake of accommodations, due to exercise, in the individual.

The factor of parental affection and training

The other examples which I take will show how parental affection gave a new importance to this principle.

First I will consider the process by which birds became bipeds, using their hind-limbs only for walking, and devoting their fore-limbs to flight. Let us assume that they first learnt to fly, by flapping along the surface of water, flying with their wings and paddling with their feet. When they took to living on land, not only would flight, being unaided by the feet, be more difficult, but they must become bipeds else their wing feathers will suffer. Now walking on the hind legs is by no means an easy feat for a bird till he has been specially adapted for it. What a clumsy creature a penguin is on land! How often he trips and tumbles! But power of running is often indispensable to a bird; many birds in the present day rise from the ground with difficulty, and without ample space cannot rise at all, so that unless they were good on their legs, they would be as helpless as a Boer without his horse. Much less could the primitive bird when he emerged onto the land do without speed of foot, unless like the penguins he was lucky enough to have no land enemies to pursue him. He must, therefore, practise and improve at running, and the result might well be that a small peculiarity of structure would be raised to importance; having a slight gift for running he would become through much practice an adept according to the primitive avian standard. And now comes in the factor of parental training, for we must imagine that having advanced so far in strength, skill, and vitality as to be able to fly, he will not leave his young to fend entirely for themselves. They will have the path of life marked out for them by their parents. They must not return to an aquatic existence, only occasionally landing for

rest, at safe spots, but they must be able to stand, walk, run in biped fashion. In fact individuals dictate to their offspring what mode of life they shall follow; choose the environment that is to act upon them, and, each generation making a similar choice, development proceeds cumulatively along certain lines; only variations adapted to the chosen environment are selected, and in a long series of generations the structures and qualities most in demand are brought to a high pitch of excellence. Two more examples will help to make this clearer.

Herons (Ardea)

Imagine the progenitors of the heron taking to fishing in the heron style. As preliminaries they must have some favourable variations; a length of leg beyond the normal, a corresponding length of neck—this is desirable if not essential—and also a beak not entirely of the wrong kind. But they do not walk on stilts like their modern descendants, nor have they the other excellencies with which we are familiar. However, by painstaking effort they get over their difficulties and survive in virtue of their piscatorial skill. Moreover, they dictate to their young that they shall be fishermen, and shall fish too in the heron style; no diving is allowed. A propensity to live on carrion is severely discouraged, though a variety of live food, including lizards, insects and worms, is permitted. Among the young some will be failures *qua* herons; will fall short of their parents' almost inadequate development; their necks and legs will suggest anything but fishing in the only style admissible. Nevertheless they will be taken to the water: from the water must come their main food supply. But those that have the heron build, being at the worst not inferior to their parents, will be successes in the line marked out for them, and thus a heron species, afterwards to be dignified as a genus containing many species, will be founded, with long legs, long necks, and ferocious bills.

Men's ncestors

One more example may be very briefly given. Let us imagine our own supposed ancestors, tree-climbing animals for long ages, at length taking to walking biped-fashion upon the ground, because the change of habit offered better chances of obtaining food. The new gait would require a whole set of adjustments, for an upright posture is by no means so simple a thing as it

seems. It requires certain favourable congenital variations, among others a certain hardness of the soles of the feet, or a tendency to harden under certain conditions. Otherwise lameness would ensue; disease or capture by enemies would follow in due course. Now among the offspring of a pair who succeeded in this new mode of life, some would have feet of the right sort, together with the other characteristics required, and would survive. Others would be ill-adapted for an upright posture and the associated habits. Nevertheless they would have to follow their parents' mode of life. The species, at the time of which we are thinking, has long advanced beyond the stage at which the young are flung upon the world directly they are born. They cannot, therefore, revert to the trees because walking is painful, and, at last, impossible for them. Their parents choose for them their line of life, thus deciding within certain limits the line of development of the species.

Force of fashion among gregarious animals

Not only parental care but also the gregarious habit, so common among animals, helps, so to speak, to give the species a continuous policy and so to promote evolution. Here, too, a few examples may make clear what is meant.

Among a herd of primitive ruminants some individual bulls may have had, where the horns now are, an exceptional thickness of bone and over it a certain epidermal callosity, not sufficient without special treatment to enable them to drive rivals from the field, but sufficient to make them enjoy sparring, so that the parts would get hardened and enlarged during their advance to maturity. Those of inferior natural endowments would improve much less quickly or break down altogether. Thus congenital hardness of head *increased by practice in butting* would become a character having selection-value, and bulls that were not richly endowed in this respect would leave no offspring behind them. Among animals living in herds there are special facilities for sexual selection by battle. All the males must fight or efface themselves: there is no standing out. And thus if they are to survive, males must vary in a certain direction, viz., towards hardness of head and weapons for butting. Hence by gradual accumulation will arise horns or branching antlers.

Many species of birds owe their success in the world to their sociability. Rooks (*Corvus frugilegus*) in their crowded rookeries or as they fly in large flocks are able to beat off their enemies. When a party of curlews (*Numenius arquata*) are feeding, it is almost a certainty that one of the number, by means of some sense or other, will become aware of any danger that is approaching and give warning to the rest. And the sociability that thus protects them we cannot regard as entirely instinctive: it is partly habit learnt in each generation by the young from their elders. And thus it comes about that the tradition of the species to some extent decides the course of its evolution by deciding the manner of life that its members are to lead. Those to whom life in a community proves uncongenial probably fall victims to enemies.

oes this inciple concile o-Dar-winism n Lam-ckism?

Can this newly-discovered principle help to heal the feud between the followers of Weissman (the Neo-Darwinians) and the Lamarckians? If it can, then the Lamarckians must have a singular power of mistaking an utter rout for a compromise. For what the new principle shows is not that acquired characteristics can be transmitted, but that Natural Selection can without such transmission do what Lamarckism claimed that it had the exclusive right and power to do. Each generation decides in the main the environment of the next and insists that it shall live in that environment. Those of the young survive who, with the aid of some training, are able to accommodate themselves to the environment in which they are put. The similarity of environment in each generation leads to selection for similar characteristics: modifications and accommodations in the individual though not transmitted are followed by variations and adaptations in the race, the very phenomenon which has always been the Lamarckian's most formidable weapon. This can now be explained on Neo-Darwinian principles, and if you can show that your opponent's theory is not the only nor the best way of accounting for the facts which he himself adduces, you cut the ground from under him. A simile may perhaps make it clear how the principle works. We may look upon a species as a huge herd of animals that are being driven along a road: the

driver being some impulse in themselves. Numerous roads lead off on either side and it is impossible to say that any one is the main road more than another. All these ways lie open, but the elders, by example and persuasion, lead the young into some road or roads swerving at no very great angle from that already followed or into the one that leads straight on. Since the young are not allowed to follow their devious caprices, it is seldom that individuals are found pressing into widely divergent paths. And so the species does not waste itself by vaguely experimenting in new directions. And hence, too, Natural Selection, a policeman who lynches all who don't go the pace or who take a wrong road, works in a limited field, among the masses that crowd the track that continues the line already followed or others that diverge but slightly from it: among these masses it acts with the utmost stringency: the laggards are ruthlessly cut off, and evolution goes rapidly on.

A possible demurrer

This, I believe, fairly represents the process of evolution in the higher species. But the Lamarckian may fairly enter a demurrer and say: "Low down in the animal scale, the new principle can work but feebly, if at all. There Natural Selection acts directly on the individual from the moment of his birth or the moment of the depositing of the egg. And yet there have been developed forms as high as the newt and the lizard—an enormous advance from the lowest types. Can Natural Selection have achieved all this? If not, we must find something that will assist it at every stage from the bottom to the top; not a principle which does not begin to operate till the higher levels have been already attained."

This objection certainly requires answering. Let us recur to our simile which represents a species as a herd driven along a road from which many roads lead off. If the elders do not guide the young, there will be perpetual deviations, most of them ending in wholesale destruction till some guiding tendency develops and is fostered by Natural Selection. This guiding tendency is rigid instinct and even that does not prevent a slaughter, mainly during infancy, enormously above what takes place among the higher classes of animals. As the crowd

presses onward, those that, passing all other roads, keep on in a particular direction will at length form a species guided by instincts that seldom swerve. Thus evolution proceeds by Natural Selection, but at the cost of an enormous sacrifice of life, even after instincts come in to reduce it. At the higher levels there is an intensification of Natural Selection, but the waste of indiscriminate destruction in a great degree comes to an end. Intelligence and plasticity are the order of the day. The monkey is a good representative of the new system: the caterpillar with his one accomplishment, of the old. Intelligence enables those who have it to make themselves at home where the creature of instinct would perish. They pass their youth in playing and imitating and thus gain a versatility that protects them amid the shocks of circumstance. They have merit of a kind that must make itself felt. Though they have marked tendencies, strong likes and dislikes, yet they have withal a certain saving pliancy and elasticity. And greater pliancy in its component individuals leads, as I have tried to show in this section, to greater adaptability in the species. The result is that among the higher plastic classes of animals evolution proceeds more rapidly.

But obviously the quickening up of evolution is not all. The individual gains in importance. He improves his powers, is able to face a change of environment that otherwise would have been fatal. He makes an environment for his young in which intelligence can be developed: he chooses the environment which they shall have when out of the nursery and so decides to some extent what qualities shall be the winning qualities in life. In fact he is beginning to take the helm and steer the species. Or we may put it in this way: when the individuals of one generation decide the environment in which the next shall grow up, selection ceases to be purely natural: it is in part artificial.

VIII

VARIATIONS AND ADAPTATIONS: LIMITATION OF THE RANGE WITHIN WHICH CHANCE HAS FREE PLAY

I have now shown that it is not mere matter of chance into what environment the young progeny are pitched. Low down in the animal world their surroundings are decided by undeviating instinct. By instinct the moth lays its eggs on the right plant, with the result that her caterpillars find themselves in the best environment. At a higher level animals have gained plasticity and power of accommodation without sacrificing the advantages of rigidity. Parental leading, or the example of his fellows of the same flock, ensures that the young thing finds himself in as good an environment as is obtainable. As the generations pass, the environment, thus chosen, changes so gradually that by the help of favourable variations the best representatives of each generation are able to cope with it. Chance is to some extent driven out of the field: the animal, be he high or low in the scale, seeks the environment that suits him.

Adaptations due to mere coincidence

But there are the variations to be considered. Are they matter of chance? The Lamarckian says they are due to external influences. But he cannot help us, since we have found that such influences have nothing to do with the matter; the environment cannot bring pressure to bear upon living organisms to make them vary into all their adaptive forms. But does the organism, owing to its own essential nature, aim, so to speak, at some peculiarity in its surroundings and so produce an adaptive variation? The evidence goes to show that adaptations are mere coincidences, mere chance hits. This evidence, since very conflicting interpretations are based upon it, I must give, however briefly.

The environment may stimulate variability

Change in external conditions conduces to variations both in animals and plants, but the variations are not necessarily adaptations. In plants, removal to a rich soil, with ample room to grow, often results in surprising deviations from the form of the original stock. The conditions, almost beyond a

doubt, act *directly* upon the reproductive cells, not indirectly through the organism as a whole. If a wild plant is moved to a garden, it will often grow there for years without any modification showing itself. Probably in the first generation of seedlings from it there will be no variations. Only after several generations will a tendency to vary display itself, and then the new character will very probably be such as to convince us that the environment has not adapted the plant to itself nor the plant adapted itself to the environment. Hoffmann, the German botanist, planted poppies very thickly together, and he found that after several generations some produced double flowers; in some cases the double flowers reappeared in the seedlings from these, even though they were allowed ample space. In fact, change of circumstances stimulated the reproductive cells to vary, and the variations sometimes reappeared even when the normal conditions were restored. This is all that can be said. But experimenters are often so delighted with their experiments that they run riot in the theories they build upon them. In this case there was no adaptation, since a double-flowered plant is no better off when jammed together with others than a single-flowered plant. I am surprised, therefore, that Lamarckians should make so much of these experiments, as if their theory had received a decisive confirmation. To make good their case they must prove two things: (1) That a new character is *caused* by the environment; (2) that the character is inherited. To take the second point first, the transmission of the doubleness is not proved; a condition of instability had been brought about, and there was still some shifting from single to double and from double to single. When variation has once begun it is likely to continue, as gardeners know. As to the other point, we must distinguish between causation and mere stimulation. If the environment causes a variation, surely an adaptation must ensue. But here it has only been what the spur is to the horse, the stimulus that leads him, *being constituted as he is*, to gallop. When variations arise, as in the poppies, in response to a stimulus from without, Natural Selection must come in before adaptation is effected. Thus the attempt to banish Natural Selection only

leads to its reinstatement.[1] But I must return to the question of chance. It is easy to adduce familiar facts that show that variations become adaptations only by lucky coincidences. A wild poppy in a corn-field is pink, while all the others round about are red. This pink poppy is no better for its singularity. But a gardener happens to notice it. He marks it, keeps all the seed, and next year there are a number of seedlings growing from it. It is clear now that the pink colour has become an adaptation. There was, in fact, a sudden change of environment. The gardener, with his taste or caprice, became an important external condition. But the variation which proved to be an adaptation to this condition, originated before the gardener became part of the environment. It was due to mere coincidence that the variation became an adaptation.

In the animal world the facts and their teaching are the same. Cattle through a congenital variation may have no horns. Now, if they are wild cattle, it is unlikely, unable as they will be to defend themselves, that they will found a hornless race or species. But if they belong to a domesticated breed, it is very likely that they may be singled out, and that a new breed may be formed. In fact, mere chance will make the variation an adaptation.

The cause of variations

Now that we have decided that adaptations are chance coincidences, we must turn our thoughts to the variations themselves. In a former chapter (see p. 33) I have traced them partly to the process of fission, partly to conjugation. When fission takes place, inequality must result. We are bound, if we are Darwinians, to assume that even the approximation to equality is due to Natural Selection. But absolute equality is unattainable. Moreover, the process of division is often a very complicated one. The elaborate structure of the nucleus goes through a number of transformations before division takes place. There is a thorough shuffling of the cards before they are cut. To adopt another metaphor, how can there be reconstruction on an

[1] As to Hoffmann's experiments see Weismann's *Germ Plasm*, p. 437, and *Essays*, vol. i. p. 420. I cannot see that the facts necessitate the concession which he makes, viz., that a new character in the germ-plasm due to the environment was inherited.

exactly similar plan after the pulling down of the building? Conjugation, no less, necessitates variation. Two nearly, but not quite, similar structures are somehow combined in one; sometimes there is a fusion of characters, often one organism has a prepotent influence. The details of the structure are unknown to us, and we can only infer their complexity from the complexity of the organisms that result: from a fertilised ovum is developed a man. When such is the character of the two structures which combine, we can only wonder at the likeness of child to parent: the differences are accounted for. And yet, as I shall show, the range of variation grows less as the organism grows more complex. The grander and more elaborate the building, the smaller the structural fault that will make it topple down.

How far does evolution according to Darwin depend upon chance?

Darwinism is often spoken of as a handing over of the universe, or, at any rate, of the organic world to "blind chance." But this is an altogether false accusation, and seems to reveal an ignorance of what is meant by chance, and also of the nature and results of scientific discoveries. The word chance is used in two distinct senses. To take that which is perhaps the commoner use first, though everything that happens is due to a cause or causes, yet when, owing to our ignorance of the forces at work, we cannot predict what will happen in a particular case, there is what we call chance. It is only ignorance that prevents the falling of a penny, heads or tails, from being perfectly calculable. In such cases, therefore, the term *blind chance* expresses only our own ignorance. Science, for her part, annexes one region after another, mastering the law that reigns there, and thus reduces more and more the domain of chance. Darwin's work, no less than Newton's, was the introduction of law into regions where it seemed there was none; evolution possibly or probably, but no one could explain how. So far from introducing chance, he extended the empire of law. But chance in the other sense—in the sense of coincidence—was esssential to evolution as he understood it.

Coincidence is the meeting of two independent forces. For example, A, while walking in a wood, *happens* to be in the line

of the shot from the gun of B, who is shooting at a rabbit. We may discover A's motive for walking in the wood; in the case of B the desire to shoot rabbits is the obvious motive. But the crossing of the two men's lines of action at that particular moment is a coincidence of which we cannot attempt an explanation. No doubt, had we full knowledge, such a thing would be as calculable as the transit of Venus. But, though this is undeniable, yet, in the case imagined, as in others of everyday occurrence, the intersection of the lines along which two forces act, is due to chance, unless we assume a co-ordinating principle which times and regulates every collision between force and force. Certainly Darwin did not make this assumption. But by recognising coincidence, he did not banish purpose from the universe and set up chance in its place. His theory of evolution requires an interplay of forces unrestricted by any central regulation. But, after all, this is but a limited field for chance: the forces themselves are matter of chance only in the sense that we are ignorant of their working. And even the limited field which he left for the play of coincidence tends, as I shall show, to become further narrowed as evolution proceeds.

I will now try to define clearly at what points chance in either sense enters into the Darwinian theory of evolution.

(1) Variations are in all cases due to chance, in so far as we cannot trace a particular one to its cause—the secret lies hidden in the germ-plasm—nor predict what variation, if any, will arise in a particular case.

(2) The sexual unions which bring about new combinations and so give rise to variations are largely due to coincidence. If favourable variations arise in a few members of a numerous species, the help of lucky coincidence will, as a rule, be required to bring it about that any of these similarly varying individuals shall pair together. If, however, their numbers are great, not much luck will be necessary.

(3) When an adaptation is effected, it is due to mere coincidence.

Of these three points, the third presents the greatest difficulty. How are we to account for the correspondence between

variations and the environment? The environment does not decide what the variation is to be, nor does the organism fashion its environment. And yet the one dovetails into the other. To explain this wonderful fact, I hope to show that there is a limit to the variations possible and a corresponding limit to the environment. To illustrate by a simile. Suppose that there is a breach in a wall through which men hope to force their way in spite of a hail of bullets. The men and the bullets make equally for the breach. Therefore it is no wonder if in the narrow space there are many hits: yet each particular hit is a coincidence.

Before going further, I must discuss Professor Weldon's theory dealing with chance in evolution. He tries to show that, according to the law of chance, similar variations will arise in plenty, so that a favourable variation is not likely to be lost (through crossing of the favoured individuals, I suppose, with others not thus favoured or through other accidents). But he does not explain why there should be any favourable variations at all (*i.e.* any that prove to be adaptations), but only why if one individual effects, so to speak, an adaptation, there are likely to be many that do so.

Professor Weldon's theory

I will first try to explain the law of chance and Professor Weldon's application of it.

When a great number of chances can be noted and surveyed, they are found to group themselves: in fact, a definite tendency shows itself. This was proved by throwing dice thousands of times and noting the numbers in each case. There was an average or mean throw, and on either side of this the numbers arranged themselves with a close approximation to symmetry—the greater the deviation either way, the more rarely it appeared. To apply this principle to evolution, Professor Weldon has taken particular features and made most careful measurements. He has shown that in shore crabs the dimensions of the carapace vary in accordance with the law of chance, and that the variations group themselves nearly symmetrically on either side of a mean. There is a large number of individuals slightly above the mean, a large number slightly below.

Measurements and observations of other animals and of plants brought out similar results. If, therefore, a slight increase in any particular dimension is of advantage, there is an ample supply of individuals in which this favourable variation is found, and if it can be proved that their slight superiority makes the difference between survival and non-survival, then, it is maintained, all is plain sailing, and evolution pursues its way on strictly Darwinian lines.[1] Our first thoughts when we reflect upon this theory may well be that there are some variations that are not of so simple a nature.

It cannot be denied that the variations in a particular dimension can be explained as deviations from a mean, and variations in the quality of tissue might possibly be described as deviations from a chemical mean. But there are some examples which hardly seem to be covered by Professor Weldon's definition. To take an instance from Mr Bateson's *Materials for the Study of Variation* (p. 201), there is in the Oxford Museum an orang-outang which has all its teeth normal except the second premolar on each side of the upper jaw. On each side there is a gap where the tooth should be. The missing tooth on the right side stands immediately in front of the canine, and has exactly the form of the second premolar. Something has pushed it out of position. The plan of the building has somehow got disarranged. But what is the mean from which there has been a deviation?

The following examples are no less difficult to explain on this principle.

Bilateral symmetry is the rule among all the higher classes of animals. But there are some notable departures from it. In snakes, of the two lung-pouches, one is reduced to the very smallest dimensions; in birds the lobes of the liver are unequal and one of the two ovaries has disappeared, the left aortic arch is missing; in mammals the left arch survives; the left tusk of the narwhal is extraordinarily developed, the right is small; domestic rabbits sometimes have but one ear.[2] In these cases also we

[1] See *Nature*, Sept. 22, 1898, where Professor Weldon's paper on the subject is reported.

[2] Darwin: *Animals and Plants under Domestication*, vol. ii. p. 12.

cannot help asking, What is the mean? Is there a separate mean, to take the last instance, for each ear? If so, the normal correlation between the two is left out of sight. But if there is one and the same mean for the two ears, then the dwindling of one is not a simple deviation from it. It is impossible to frame a formula to cover all sorts and kinds of variations. The shifting forms which living organisms assume suggest crystallization more than anything else. There are certain positions of stability, to use Mr Galton's phrase, and some members of a species settle in one of them, others in another. The right-handed helix is the rule among some species of snail, but occasionally the left-handed form makes its appearance; there is a sudden shift, not a gradual accumulation of small variations on one side or other of a mean. There is good evidence of peach stones producing nectarine trees, and nectarine stones peach trees; there are two forms in fact, and the species shifts from one to the other, but there is no mean between the two.[1] Five hundred and eighty-three male earwigs in which the forceps was measured divided up into two groups characterised respectively by long and short forceps; *an intermediate length was found in very few.*[2] When the cephalic horn of three hundred and forty-two Lamellicorn beetles was measured, a similar grouping showed itself. The species shifts between two forms; the grouping is not that of the law of chance. Sometimes, again, there is a sudden multiplication of parts; two spurs appear in a species of bird that hitherto has had only one.

Positions of stability

But an objection may, perhaps, be urged against all this. "Such crystallization, such kaleidoscopic shifts can only multiply or rearrange organs that were already there, it cannot produce any new organs." Strictly speaking, there is nothing new at any stage in evolution; you cannot find an absolutely fresh beginning. To take an instance, the outer cells harden and there is an epidermis; further specialisation follows. Scales are elaborations of the epidermis, outgrowths from it; feathers are elaborations of scales. Again, hair and feathers are equally

[1] Darwin: *Animals and Plants under Domestication*, vol. i. p. 340. 1868 edition.
[2] See Mr Bateson's *Materials for the Study of Variation*, p. 41.

epidermic growths and the differentiation involved no new departure, but merely specialisation in two different directions. There may have been sudden advances by not very minute steps; much increased specialisation of cells, great increase in the size of the hairs or scales. But such advance whether by long or minute steps is only an accentuation of characters already present, and so cannot be said to involve a new departure any more than the variations which I have compared to crystallisation, or to the arrangement of patterns in a kaleidoscope.[1]

Not only does Professor Weldon's formula in many cases break down as a diagnosis of variation, but it does not help to explain adaptations—why the right variation appears at the right time. It only aims at proving that there will often or always be a sufficient number of individuals varying in the same direction at the same time—plenty of material for Natural Selection, *if it is only of the right sort.*

I shall now try to show how the possible amount of deviation from the normal is limited by a principle less mathematical, but, I believe, more efficacious than Professor Weldon's. This principle, viewed in connection with what I have to say about the nature of the environment will, I believe, help to make clear why it is that the various groups seem, as a rule, to follow each its own line of development instead of wasting their resources on haphazard variations that make no hits and effect no adaptations.

Heredity limits the range of variations

The range of variations possible to a species is limited by heredity; the course of its evolution beginning in an age, even geologically, remote has impressed upon it a certain character, and to this character heredity insists that it shall be faithful. Even the lowest organisms that we know, specks of protoplasm in which it is difficult or impossible to find a nucleus, have, no doubt, arisen from simpler forms. They belong to species that have, there is reason to believe, each their own phylogeny, their stages of evolution. Already we have cell-structure;

[1] In *Natural Science*, May 1899, I used the term *New Departure* to mean a discontinuous variation. It is certainly best to keep clear of the word "new" as likely in this connection to mislead.

already the system of multiplication by fission is in full swing and further evolution is conditioned by this. If there is to be great increase in size it can only be by one method: the resultant cells when fission takes place may cling together, and thus we shall have one of the metazoa or multicellular organisms. This stage attained, further possibilities lie open. There may be division of labour; certain cells may specialise and undertake particular duties. As we ascend to higher and higher stages we see the same principle, limitation of possibilities by heredity.

To show this I take a genealogical tree giving the supposed lines of descent of the various existent classes and sub-classes of animals. Häckel's tree (*Evolution of Man*, vol. ii. p. 188), is generally acceptable enough for our purpose, though, no doubt, every biologist would prefer to draw out his own. We will begin by taking a point more than half way up the tree, where the Selachii, primitive fishes, are found. From these we find branching off the various sub-classes of fishes and the amphibians. Should the former course be followed there are paths leading towards the ganoids, the osseous fishes and the mud-fishes. There may have been other possibilities which never became actualities, other actualities of which we have no record. But when once one of the other alternatives, whatever their number, had been definitely chosen, development on amphibian lines had become an impossibility. It is true there may be retrogression, but when this takes place it is always partial: some features are retained while others are lost or dwindle. This being so, every advance may be looked upon as a point gained from which a further advance may be made. Every advance cuts off certain possibilities and opens up others. As the stages traversed recede further and further into the past, return to them becomes increasingly difficult and at last impossible. Evolution can only in theory reduce elephants to protozoa. Its method of advance may be compared to the system of case-law, in which the interpretation of the law by a judge, at any rate if upheld on appeal, becomes binding on all judges before whom similar cases come up for trial. As we advance upward from the lowest forms of life, we see this

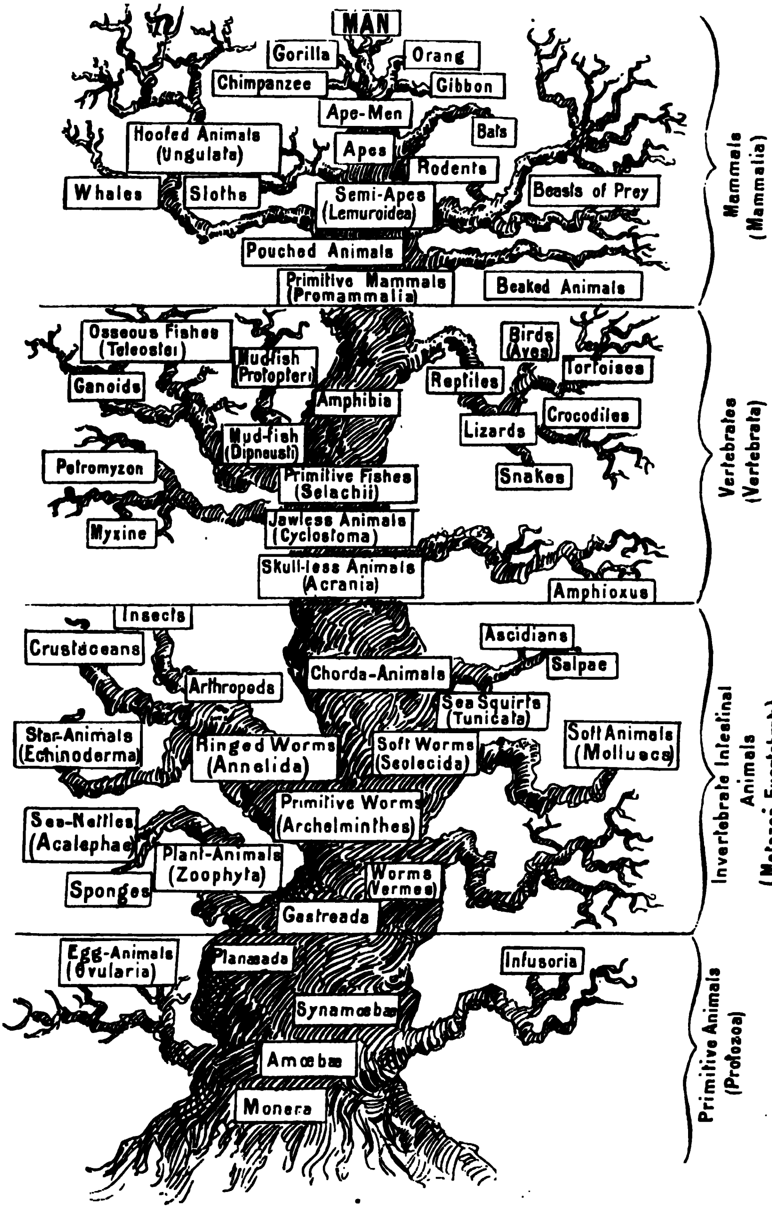


FIG. 14.—Genealogical tree from Häckel.

principle constantly at work: no species has complete freedom to wander; it is restrained by heredity. Though it may deviate, it may not go beyond certain limits. Thus primitive reptiles had before them at least two widely different possibilities, avian and specialised reptilian lines of evolution, whereas a species of bird, if evolution proceeds further, can only modify the avian type or the type of its particular species or family. It may, in fact, become a new kind of bird, even a bird in which some of the avian characteristics have lapsed, but complete retrogression replacing it among the reptiles, is almost, if not quite, an impossibility. The amphibian type is even further out of reach. As we ascend it will be seen that the lines along which species may develop, though certainly not less in number than lower down in the scale, are less divergent one from another. A primitive bird, as the birds of to-day show us, was capable of evolving an enormous number of specialised forms, but the distance between any two of these is as nothing compared with the distance between the descendants of primitive protozoa. The more elaborate and complex the organism, the narrower the limits within which further evolution must proceed: the narrower the limits within which play is given to mere chance.[1]

Though I have tried to guard myself against it, I may have seemed to be speaking of known forms as the only possible ones. I am far from thinking that. The known species, living and fossil, may be far less in number than those of which we have neither record nor living representatives. I only maintain that every species, at whatever stage of evolution, has a limited

[1] Eimer—*Organic Evolution*, p. 52—writes: "I assume with him (Nägeli) that the condition for a progress towards the more complex and towards division of labour exists in the fact that a higher stage once reached can afford a foundation for one still higher, since the former, the existing stage, will necessarily be the starting point for further modification." When reading his book some few years ago, I passed over this passage, failing to realise its importance. I have now arrived at what would seem to be the same position independently, or, it may be, have recurred unconsciously to what I read there. But Nägeli, to whom Eimer refers, regards Natural Selection as at best only an auxiliary principle. And Eimer is a strong Lamarckian. My views, therefore, are very different from theirs, though they meet at one point. See Weismann's *Essays*, vol. i. pp. 262, 306.

range of variation, the limits being set by the path of evolution followed hitherto, the organisation already attained. Within these limits there may be an infinite number of variations just as a botanical systematist may subdivide his families into almost unlimited species and sub-species. This does not alter the fact that heredity keeps a tight hand even on the most variable groups limiting strictly their methods of adaptation. An example will make this point clear. In the wings of birds, if we consider size, structure and colour, there is no end to the variations we may find. Even the legs show peculiarities which are numberless if the minutest difference is considered worthy of notice. But supposing that locomotion, for instance, is the burning question, there are only two means possible for birds: there is flight by means of wings (avian wings, that is), and there is a biped gait. Wings involving the two pairs of limbs, such as a bat possesses, or a quadruped gait, are out of the question. In fact, if the conditions become more stringent, birds must adapt themselves by improving along the lines on which they have already advanced so far. To specialise on different lines they must first revert to a more primitive form. But such reversion requires a slackening of the stress of competition: such as seclusion on an island where there are few rivals. Not a few Crustaceans have resigned their free-swimming life and have affixed themselves to rocks, or as parasites have lost nearly all their distinctive characters. But birds have advanced too far to resort to such slums and back ways. For them, except under very exceptional conditions, further adaptation must mean further perfecting of their existing powers. Widely different forms may at length arise, but it can only be through long continuance along slowly diverging lines.

All that I have said on this subject is only an amplification of what has become a Darwinian commonplace: the offspring tend to be like their parents but not exactly like. The principle of heredity governs the variations no less than the resemblances. If a breed of horses tends to vary, the variations are equine and not bovine. It would be strange indeed if the organism, after roughly but truly recapitulating its phylogeny and going through

a series of definite phases, at the end of the prescribed course were are liberty to break out into wild haphazard developments. Law and order so perfect surely never ended in chaos. There is freedom to vary, but freedom within limits. Nevertheless, even if variation were chaotic, if any animal might produce any kind of organ, even then, given an unlimited number of individuals in a species, mere coincidence might, it is imaginable, produce a sufficient number of representatives of some new type to form a new species. But the great results achieved by breeders of cattle, horses, pigeons, and other animals, have been attained in many cases with quite small numbers. When breeding for some particular point they have generally been able to find more than one among the few at their disposal in which the required tendency was traceable. The smallness of their resources and the greatness of their achievements drive us to the conclusion that variation is within certain limits.

Convergent volution

To pass on to other evidence of limitation, we find among evolutionists a growing tendency towards the view that species and even larger groups not seldom tend to converge. Like forms arise independently. There is reason to believe that in the ostrich and its allies we have instances of convergent evolution: they are probably polyphyletic in origin, and have drawn towards one another. The dentition of the marsupial animals, according to their food and habits, approximates to that of placental mammals of similar habits. The heart of a bird with its four chambers is strangely like the heart of a mammal and the difference of the avian and mammalian valves between the two right-hand chambers only serves to bring out the similarity of the main architectural features. In the Aye-Aye (*Chiromys*) the teeth completely simulate those of a rodent.[1] In this connection much might be said on the subject of what Darwin called analogous variation.[2] In all cases where we see convergent evolution or analogous variation, we must assume that the two groups before they parted company had reached a stage of

[1] See Huxley, *Man's Place in Nature*, p. 84.

[2] *Animals and Plants under Domestication*, vol. ii. pp. 348-352. See also Eimer's *Zoologische Studien auf Capri*.

evolution at which the characters which they share are potentially present: they are possible variations.

Correlation

It might be thought that, though the specialisation of complex animals may set limits to the range of their variation, yet that the number of possible forms within those limits would increase with their complexity. Some check is put upon the increase by the correlation of various parts. The subject is very imperfectly understood, but what is known enables us to see that the organism is no mere aggregate of units but that a variation in one part involves a variation in several others. There is a system of mutual dependence between organ and organ, which, as our knowledge grows, is found to extend and have an importance formerly undreamed of.[1]

Sequence of variation

I now pass on to what I shall call sequence of variation, the known likelihood that among the offspring of parents in which a particular variation has occurred some will vary in the same direction, so that if a flower shows a tendency to doubleness some of the seedling plants from it are likely to show the same tendency in a greater degree.[2] This, of course, does not hold, if the plant is crossed with another that has not the same peculiarity: there must be isolation. Given isolation, there is likely to be a second step in the same direction and, *if there is selection*, *i.e.* a series of isolations, the process is likely to continue.

We have now in our consideration of variations discovered two principles which limit the field within which chance holds sway.

(1) Even in its variations an organism is bound by heredity: it cannot deviate far.

(2) There is such a thing as sequence of variation under the conditions just explained.

Can we attribute the evolution of all species to an inherent tendency?

After what I have said, the question, however unreasonably, is sure to be put: "Was the evolution of the various forms of life—of mollusc, crustacean, reptile, bird, mammal—necessitated by the nature of the primitive protozoa? Was there an in-

[1] See p. 80.

[2] Darwin called this *continuity of variation*: see *Animals and Plants under Domestication*, vol. ii. p. 241, and index under *variation*. I avoid the term because variation by long sudden steps is now called discontinuous variation.

herent tendency towards evolution on particular lines?" The answer must be a decisive negative. Had it been so, we might have expected identical forms to be developed in different parts of the world, and this is very far from being the case. Australian mammals have not progressed beyond the marsupial stage. *At every step in evolution there must be the coincidence of a suitable environment*, to select the variation in question for survival, or else it will be lost. And though the nature of the organism limits the angle of deviation, it sets no limit to the eventual amount of divergence. The evolution of species is not like the driving of pigs along a road railed in on either side and with no roads leading off. There are endless branching roads, but they slope away at a small angle, and to those individuals that choose unadvisedly Natural Selection is perpetually giving the *coup de grace*, so that by no means all variations prove to be adaptations. But all this does not prevent us from holding that, given protoplasm and given the physical conditions that have prevailed upon the earth since the appearance of life, organisms, having in various combinations the main characteristics of those that exist, were bound to appear. Thus much may be allowed. The particular forms evolved are due to the interplay of organism and environment, the latter consisting largely of competing organisms. Much, then, was inevitably left to chance. On the one side there has been a succession of grim necessities, on the other a succession of chance adaptations.

ness of ɔtation We must now consider adaptations further to see how chance can have brought them about. If we begin at the wrong end, as people are too apt to do, it seems an insoluble problem. Even such a familiar bird as the domestic duck is a mass of adaptations, and that it should have fitted into its elaborate environment to a nicety seems too great a miracle for a system in which chance plays a part. It will be much better to begin at the very base and picture to ourselves an unspecialised animal in an unspecialised environment. Our primitive animal, a blob of protoplasm, must be able --(1) to get oxygen from the water in which he lives; (2) to get protoplasm for food; (3) must propagate his kind; (4) must stand changes of temperature; (5) he may have to kill or escape

from enemies. Now, these are all inconceivably difficult problems, but animal protoplasm in its simplest form has already solved most of them: it can act as a lung taking in oxygen and letting out carbonic acid gas: it is not particular as to what protoplasm it has to assimilate. As to enemies, if they exist, they are no more, or little more, specialised than itself. But here it becomes apparent that we have been trying to imagine what cannot exist—an animal without any adaptation to a special environment. It must have some specialisation in order to lay hold of the protoplasm it requires for food. If definitely animal, it cannot be absolutely non-specialist. But though our completely generalised animal is an impossibility, several points have come out clearly. First, of all the powers of the most complex animals, how large a proportion is possessed by the simplest of all! secondly, how much of all the dowry of the simplest is its heritage from ancestors less definitely animal! How little is due to lucky variations appearing first in it! Consequently how easy is the process of adaptation when only slight extensions or deviations are required to meet a slight change of environment!

We will now take an animal of great complexity, a Peregrine Falcon. Its adaptations are exquisite. But nearly the whole of the sum total was accumulated before the birth of the individual in question: on the top of the huge accumulation he stands and faces the world. For generations past only slight improvements here and there have now and then been wanted, the finishing touches of an artist. Such adjustments have enabled the species to contend against each slight increase in the stringency of the conditions of life or each slight change in them. But why has the increased stringency or the slight change been such that a suitable variation was likely to arise? To understand this we must consider what the environment is. It is made up mainly of the species in contact with the one we are considering. Physical conditions, as far as evolution is concerned, act only indirectly as long as they remain constant. A good enough way of withstanding changes of temperature has, let us suppose, been already secured. But to keep pace with a rival species greater vigour is required and greater vigour implies

Nature of environment

greater superiority to heat and cold. Evolution, in fact, has been a struggle among competing groups; physical conditions have led to an advance only when they have increased in rigour. This being so, the environment of a species is mainly the species with which it has established a *rapport*. Now in a previous section (p. 103) I have shown how the competing groups advance *pari passu*. Thus the Peregrine Falcons and their environment have been developed side by side during the slow process of evolution. There have been endless mutual adaptations and now all the competitors stand, each on the top of the huge pile it has thus accumulated. For each the great mass of adaptation is old-established. For each, heredity decrees that there shall only be variation within a certain range—unless indeed reversion set in and that would at once be checked by the keen competition. And—something more definite still—there is the principle of sequence in variation: among the offspring of parents, in which a particular variation has occurred and been protected by isolation, some are likely to vary in the same direction. This principle will be at work among the *environing species* and the *environed*, if we like to distinguish them thus in thought, producing further the parallel lines.

We can now see that there are two limitations to the field within which chance has free play: (1) heredity limits the range of variation for each species; sequence of variation extending the principle further. (2) *The environment also undergoes evolution; in its case there are corresponding limitations.* This is obvious when we bear in mind that when a number of species are *en rapport* with one another each is part of the environment of all the rest.

In this way we can explain the happy coincidences that arise when the *rapport* between a species and any part of its environment has been once established. But how does the *rapport* arise in the first instance? This too admits of explanation. There are times in the evolution of many species when no great nicety of coincidence is necessary, because there is a choice of environments, with any of which a connection may be established, and often there is a variety of possible adaptations to one and the same environment. For example, many plants must have means

Several possible environments

of scattering their seeds to a distance if the species is not to be exterminated. To effect this, various agencies are available. There is the wind, there are animals, and of animals there are various kinds. The plant may by a lucky coincidence establish a *rapport* between itself and any of these: until the *rapport* has been established, it is free to choose—it is hard to avoid this incorrect word. No sooner, however, has it been established than the freedom of choice is gone. Competition with rivals necessitates further improvement along the line adopted. It is too late in the day to begin another policy, to start *de novo*, when the competitors have advanced far beyond the rudimentary stage. All this becomes clear when we consider some very familiar seed-scattering contrivances. Among those that work in connection with the wind are the samara, the fruit of the maple (*Acer campestre*), and the thistle-down, both excellent; also there is the little round gourd of the colocynth, which the wind-storms send bowling over the sands of the Sahara. Appealing to birds to carry them are strawberries and blackberries, and scores of others; appealing to woolly or hairy quadrupeds are burs. For the more primitive plants, from which the elaborate forms of our day have sprung, the dispersal of seed was a problem of which there were many possible solutions. Now for each elaborated species there is only one. It began to specialise long ago, and is bound to keep to its old methods.

Variety of possible adaptations to exactly similar environments

There are other cases where we see a variety of ways of effecting a *rapport* with exactly similar environments. The hop-plant, the white briony, ivy, all make use of trees or shrubs to support them. But their methods are very different: the hop twines its stem round its prop, the briony holds by its tendrils, the ivy by little rootlets. Hungry animals are part of the environment to which plants have to adjust themselves. And they adopt various means of defence (it is hard to avoid speaking as if they acted with a purpose in view). They become nauseous or thorny. And the thorns or spines are of various kinds. They may be really branches—proving this, little leaves may be seen on the spines of the hawthorn—or hardened cells as in the brier, or stiffened veins of leaves as in the holly. For many butterflies, birds are an important part of the environment. They may adjust

themselves to it (1) by developing great power of flight, or (2) an offensive taste; (3) they may "mimic" another nauseous species, or (4) come to resemble some such thing as a dead leaf, and so be protectively coloured. The higher animals have to find some means of keeping down their temperature when the thermometer stands very high, or when they are taking hard exercise, and they may manage this either by rapid breathing, as all birds do, or by means of perspiration.

The environment, properly defined, is rigid

In the light of such facts, ought we to speak of the environment as plastic? The answer depends on the definition of the word environment; rightly defined the environment of an organism includes everything external to itself *with which it is in any way en rapport*. The limitation which I have emphasized by italics is important. Other things are no more part of its environment than ghosts are part of ours, if, however near at hand, they are imperceptible by any of our senses. If we define the environment thus, it is by no means plastic, it is rigid.[1] An adaptation having once been effected, there must be no non-conformity. The camel, having made the desert his habitat, must eat such food as the desert supplies, or else remove to other regions where the conditions are different. Beasts of prey being part of their environment, antelopes must somehow, by speed or wariness, escape from them. Plants that trust to sheep or cattle to carry their seeds must grow burs that will stick. The environment is a despot to all that have once become its subjects.

But though absolute conformity is required, yet there are various ways of conforming: the hop, the briony and the ivy prove this. Moreover there are often alternative environments, with any of which a satisfactory *rapport* may be brought about. The species is, in fact, in the position of an Oriental people: its liberty is the liberty of occasionally choosing a new despot. Moreover it has a privilege which Orientals have not always: it may carry out orders in one of several ways, adopting what for it may be the one way possible.

[1] I was certainly wrong in using the term "plastic" of the environment in *Natural Science*, May 1899. But my contention now is the same as then. I have only expressed it more correctly.

Evolution by Natural Selection is evolution brought about by chance coincidences, chance hits, variations in the species *happening* to suit some feature of the environment. But from the very earliest stage the range of variation possible is limited by heredity, and as evolution proceeds it is still further narrowed. Similarly the environment (or at least the environing species of which it mainly consists) has, as a rule, been evolved *pari passu*, and its range of variation is limited by the same principle. Thus heredity decides *vaguely* for the species what its future is to be. The environment—itself evolved side by side with the species on parallel lines, so that there is likely to be further parallelism—decides *definitely*. Summary

Thus there is chance, but chance within certain limits on either side, in the species and its environment. This limitation, makes the lucky coincidences, which we call adaptations, intelligible. They are often facilitated by the fact that there are alternative environments or alternative methods of adjustment to the same environment, *till the organism has adopted a particular method of suiting itself to its conditions.*

I will now recall the conclusion arrived at in the previous section.

Chance does not decide in what environment the young of a species shall place themselves. Among the lower classes of animals there is instinct as a guide. Higher up, parents first make a sheltered environment for their young, then in many cases direct them to the environment best suited to their years of maturity. They intervene to save the next generation from the tender mercies of chance. Among social species the same principle is carried further.

As evolution proceeds, therefore, chance works within ever narrowing limits.

IX

CONSCIOUSNESS

When one has realised all that embryology has to tell, and when one has seen how the various classes of animals may be arranged in a genealogical tree on a system suggested by the

stages through which a human embryo passes, then it becomes possible to believe in evolution. But difficult questions arise, and perhaps the most difficult is this: when in the animal series did consciousness first make its appearance? We cannot tell how far the lower animals are conscious, so that it cannot be expected that any direct evidence should be obtained to enable us to answer the question definitely. Yet an evolutionist must not complain if an opponent argues thus: "Can you account for consciousness on evolutionary principles? If you have to assume that at a certain stage consciousness was not evolved, but implanted, then your whole theory has received a fatal blow. A law that has only a partial operation, dealing with only some of the phenomena of animal life, is an absurdity." With this last statement everyone must agree. As evolutionists, then, we are bound to hold that consciousness in its highest form is the culmination of a long series of stages of development beginning with something dim and rudimentary. We are bound to believe that it is co-extensive with life, whether animal or vegetable. But low down in the scale it is, of course, so rudimentary that, to use Professor Mark Baldwin's expression, "our terms become eviscerated of their meaning."[1] As the criterion of mind we may adopt selective reaction. Any organism, whether vegetable or animal, selects what it requires as food and rejects what is unsuitable. In the lowest stages of animal life, and in those strange forms which hover between the animal and vegetable kingdoms, it is wonderful what sensory and mental phenomena—big words, but justified by the facts—present themselves for our study. Has not M. Binet written a book on the *Psychic Life of the Micro-organisms*?[2]

Consciousness assumed in the lowest organisms

Euglena and others have pigment spots which, probably, are so far eyes that they enable them to move towards the light. A volvox consists of a colony of organisms, each of which has two flagella or threads of protoplasm. Since all these flagella swing in time together we must assume that there is the equivalent of a nervous system to co-ordinate their movements. Yet

[1] See his *Mental Development in the Child and in the Race*, pp. 208-214.

[2] Published in the *Religion of Science Library* at Chicago.

the volvox, judged by one important test—its possession of chlorophyll and its diet—is a vegetable. Didinium, a hunter Infusorian that throws trichocysts (little javelins), distinguishes two nearly allied Infusorians, Paramoecium aurelia and Paramoecium bursaria, from one another, attacks the former and avoids the latter.[1] Even bacteria have their wits about them; a drop of poisonous acid causes a *sauve-qui-peut*, and, as everyone knows, they know whom and what to attack.

Can such acts be entirely unaccompanied by consciousness? It seems to me unlikely. Consciousness, as we know, may be complete or incomplete. While writing I have been dimly conscious of a lamp, a ticking clock, a fire sleepily burning, and so forth. My conscious thoughts have been focussed upon the micro-organisms and their "psychic" life, if with M. Binet we may so dignify it. Is it not possible that they may have something similar to what we call sub-consciousness in ourselves? In thinking of these matters it has sometimes occurred to me as a difficulty that our lower nerve centres are far higher in the scale than these protozoa which have no cells at all set apart as nerves. These lower centres must, I believe, have a dim consciousness of their own. If the disarrangement of the bedclothes allows a cold draught to penetrate to us when asleep, we sometimes withdraw a foot or a hand without waking. But can we be sure that there is no consciousness in some lower part of the brain or in some nerve ganglion which orders the movement? If so, it is not we who are conscious but a subordinate official in our service.

We decide, then, that where life is there is mind and there is consciousness. Let them be as rudimentary as it is possible to be without being non-existent. They must be there since the other alternative, that they have been implanted at a comparatively late stage of development, is inadmissible.

The expression "the all-sufficiency of Natural Selection" was first used, I believe, by Weismann, and, though true in my opinion in the sense in which it was used, is undoubtedly liable to misinterpretation.. It was meant to express his view that the

[1] *Loc. cit.*

Lamarckian principle was superfluous and unnecessary. It must not be taken to mean that Natural Selection governs the universe.

It is inevitable that when a great scientific discovery has been made it should at first be thought to be more far-reaching than it really is. So it has been with the Darwinian theory. What life is has always been a problem that man has wished to solve. Lucretius, in his native simplicity, thought that it was solved by the atomic theory which he worshipped. In the same way on the subject of Darwinism there has been much exaggeration, much wild talk, as if the great riddle had now been guessed. If we strip off all untenable inferences, Darwinism is nothing but this—the very probable hypothesis that the highest species of animals have been gradually evolved from the simplest forms, at any rate, mainly by the action of Natural Selection. In the lowest types that we know sleeps the possibility of the highest. But the old enigma is still with us—what life is, remains unexplained. It is a great thing to know, or to have good reason to believe, that the lowest micro-organism contains potentially all the qualities that ennoble man. But this only makes the real mystery a mystery greater even that it was. We seem to have got near the inmost secret of nature and yet are infinitely far from it.

X

SUMMARY

The following are the positions which I have tried to establish :—

The struggle for existence that is always going on is not always a struggle among individuals. Very frequently there is mutual help among the members of a group which only by means of that is able to hold its own. The stress is felt only at recurrent crises; an animal must be able to face these emergencies if he is to survive. During the pauses in the struggle the survivors have a superabundance of vigour.

Though Natural Selection is always acting by means of the

struggle for existence, yet certain characters which, though useless are harmless, sometimes survive and remain constant, or fairly constant. Hence the extraordinary number of species (some of them probably mere varieties) of willows and briers in the British Isles and of shells in the Sandwich Islands.

The variations on which Natural Selection has to work are usually small, but occasionally large. Even very slight differences may cause survival or destruction.

There is not wanting evidence that the tendency to retrogression is, but for the constant elimination of the inferior, stronger than the forward tendency. Weismann, therefore, is right in holding that Pammixis can undo the work of Natural Selection even without the aid of reversed selection.

The shedding of characters that have become useless and cumbersome is one of the conditions of evolution. The addition of new organs is accompanied by the disappearance or reduction to the minutest dimensions of such as have become obsolete.

A number of species are evolved simultaneously. A forward step in one necessitates an advance in those that come in contact with it.

Nothing but change of environment can lead to further evolution. When the conditions remain the same, elimination tends only to produce organic stability.

The pace of evolution has varied at different periods. It is possible that among certain species at certain times in certain regions a condition of equilibrium may be attained so that in these species nothing beyond greater stability may be in process of evolution. On all sides now there are highly specialised organisms and this makes it impossible that the circumstances under which evolution began can ever be reproduced. In the lower species much of the elimination is indiscriminate, the fit and the unfit being alike destroyed. The amount of such waste is much reduced among the higher plants by machinery which secures the safe transference of pollen and the scattering of their seeds. Among the higher animals waste is checked by a far more effective system, by the care of parents for their offspring during their immaturity. The struggle comes when growth has

brought out and developed small innate points of superiority and given them selection-value. Exercise and play co-ordinate muscular activities so that the machinery works without jarring. Play is a rehearsal of the serious business of life and by fostering intelligence and skill further tends to make the issue of the coming struggle depend on merit and not mere chance.

Besides preventing waste, exercise, as Professor Mark Baldwin and Professor Lloyd Morgan have shown, has another important influence. We have seen that exercise may so raise the value of some small congenital variation that it decides the question of survival or non-survival. Hence it follows that individuals owing to modifications brought about during the ontogeny, during the individual life, may make shift to meet new circumstances for which by natural endowments they were imperfectly prepared. Race variations will follow the direction pointed out by these modifications. Only in the light of this principle are we able to understand the full significance of the education and training of the young by their parents. It directs to some extent the working of Natural Selection and, consequently, the line along which evolution proceeds, since the determination of habits and of the conditions of life is the determination of the qualities in virtue of which the species shall survive.

The principle just explained is no real reconciliation of the views of Lamarck and Weismann, for it rejects the Lamarckian explanation of the origin of variations. It even strengthens the position of the Neo-Darwinians by showing that Natural Selection can, without any surrender, make use of Lamarckian methods. For it we may claim that it hastens the process of evolution by keeping a species on its line of development, at the same time leaving it plastic, intelligence, to a great extent, taking the place of rigid instinct. It fails, however, to account for *the appearance of the right variation in the right place*, insuring only that the variation is made the most of when it appears.

How are we to explain what appears to be the fact that there are not in each generation thousands of variations, and all of them ill-suited to the conditions? No species can suddenly get rid of the character which its long phylogeny has given it.

Heredity limits the range of variation unless there is reversion and this can proceed far, only through the adoption of a parasitic life or by retirement to sequestered regions where the stress of competition is less. But heredity governs the environment no less; for the important factors in the environment are, as a rule, the competing species and these have been evolved *pari passu* with that one whose evolution we are considering. Thus in the matter of variations the field of chance is limited, nor is it an utterly chance environment with which the adaptation has to be effected. There are limits on either side, but within these limits chance has free play: an adaptation is a coincidence. Nor is there, apart from selection, a definite tendency. It is true that it has been found by breeders and gardeners, that if a variation appears and is preserved by selection, greater variations in the same direction are likely soon to show themselves. But there is nothing antagonistic to Darwinism in this. At every step selection must clinch the new development. It follows from this that mere isolation could not, by allowing a fair field to an incipient variety, bring about much further evolution.

Often alternative environments offer themselves, and this makes the coincidence on which adaptation depends comparatively easy. A species of plant may come into *rapport* with the wind or birds or mammals, hence the variety of the modes of fertilisation and of transporting seeds.

The further specialisation has proceeded, the narrower has become the range within which chance has been allowed to operate.

The problem of the origin of consciousness puts us on the horns of a dilemma. Either consciousness is present in the lowest forms of life or else it was introduced at a higher stage of development. The latter alternative is abhorrent to the very principle of evolution. We are driven, then, to believe that even the micro-organisms whether animal or vegetable have some consciousness, however dim.

Lastly, Natural Selection is only a regulating principle, not a force; it has but guided the evolution of living organisms. Logic compels the evolutionist to assume a force that was not evolved, but which existed before evolution began.

Chapter V

SEXUAL SELECTION

No one can dispute that there is such a thing as sexual selection by battle. The bucks fight for the lordship of the herd, the bull seals to defend their harems from intruders, barndoor cocks for the supremacy of the farmyard. This form of sexual selection is matter of every day observation. But Darwin contended for a great deal more than this. He maintained that in very many species the females chose their mates, and to this source he traced many of the most extraordinary structures found in the higher animals, such as the plumes of the peacock and the bird of paradise. These are among the *chefs-d'œuvre* of sexual selection. If, however, we are true Darwinians, we must not begin by studying such superb elaborations, but see first whether in lower classes of animals also there are secondary sexual characters less developed and less conspicuous. Better still will it be if we go to the very base and see whether the differences between the spermatozoon and the ovum correspond in any way to the differences between the sexes.

Spermatozoon and ovum

There is reason to believe that the germ-plasm itself is non-sexual, for male characteristics are often transmitted through the female. But the reproductive cells, as distinguished from the germ-plasm which they contain, differ in the most marked way. The male cell is active, the female inactive. In the hydra it is the spermatozoon that breaks loose from its place and goes to seek the ovum.

The sexes maintain the distinctive characters of the reproductive cells. In all species—the exceptions are too insignificant to be worth mentioning—the male seeks the female, the male is active, the female comparatively sedentary.

With the greater activity of the male is associated a greater

tendency to vary. Some special adornments of the male sex, *e.g.* the horns of some beetles, are variable to an extraordinary extent. In the human race not only is genius more frequent in the male sex but also congenital idiocy.[1] Even in such a thing as hare lip this greater tendency to deviate from the normal shows itself. Zoologically speaking the female is the conservative element of the race and the male is the progressive. In any theory that attempts to account for the antlers of the stag and the plumes of the peacock, this fact must not be left out of sight.

Secondary sex characteristics

We must now look for the first appearance of what are ordinarily known as secondary sexual characteristics. It is among the arthropods, among which are included crustaceans, insects, spiders, scorpions, and others, that the first unmistakable beginnings are found. In lobsters and crabs the *chelæ* or pincers are generally larger in the male. Probably these are used for battles with rivals, certainly they are employed to seize the females; in many crustaceans there is a wonderful elaboration of such clasping organs. In point of colour the sexes seldom differ, but, when they do, the male has the advantage, though as a rule the superiority consists only in a slightly greater depth or brightness of tint. In *Squilla stylifera*, however, a crustacean found in Mauritius, the male is a "beautiful blueish green, with some of the appendages cherry red, while the female is clouded with brown and grey, with the red about her much less vivid than in the male." [2]

Passing on to spiders we often find decided colour distinction between the sexes. Moreover, the male is nearly always smaller than the female, and his courting, as described by those who have seen it, is one of the most extraordinary things in Natural History. He goes through the most astonishing performance of antics, intended, there is every reason to believe, to obtain the female's favour. He may make as many as a hundred and eleven wild gyrations round her to say nothing of other acrobatic feats.[3]

[1] See the *Census Report* for 1891, vol. iv. p. 76.

[2] Quoted by Darwin, *Descent of Man*, vol. i. p. 385.

[3] See George W. and E. Peckham on *Sexual Selection in spiders of the family Attidæ* (Milwaukee).

At the end of it all it sometimes happens that she is not charmed, and devours her little suitor! Are we, like de Geer when he saw this catastrophe, to be "filled with horror and indignation," or are we to laugh? At any rate all will agree that it is a fine system for selecting the boldest and most vigorous males.

It is among spiders that we first find a power of making sounds, which, limited as it is to the males, we may consider to have been developed in connection with sex. It is a stridulating noise produced by rubbing a ridge at the base of the abdomen against the hinder part of the thorax and is much feebler than the music which insects make by similar means.

There is no need to say much about insect musicians. They include crickets, bees and grasshoppers. As a rule the notes emanate from the male alone, and there can be little doubt that their object is to call the female. The song of the cicadas has charms for Chinamen who keep them as pets, but in Brazilian forests, where the whole air rings with the din, it is the fair sex of the species who are being serenaded. Among the insects that are not musicians many have wonderful adornments that are more striking in the males, if not peculiar to them. Among these decorations are to be included the enormous horns of some species of beetles, for apparently they never fight with them. But pugnacious insects are not wanting. Male field-crickets are great fighters, and the Chinese, at once so ancient and so childish, "keep them in little bamboo cages, and match them like game cocks." [1] Male stag beetles—what else could their enormous mandibles be for?—have great battles among one another.

In all the five classes of vertebrates — fishes, amphibians, reptiles, birds and mammals—we find secondary sex characters. The male stickleback (*gasterosteus*), all crimson and green, dances round the female when he has driven her to his nest. The little polygamist makes the eggs his peculiar care and defends them against all comers, even his wives, who are apt to cast cannibal eyes on their own offspring. Male salmon fight much among one another and in some fish the male is far the more brilliant. The male dragonet is so bright with blues and yellows that

[1] Darwin: *Descent of Man*, p. 360.

Linnæus considered the dingy reddish-brown female the representative of a different species.[1]

Among amphibians there are sometimes colour differences between the sexes, *e.g.* in the newts. But the most striking sexual distinction is the great development of the vocal organs among frogs and toads. In Teneriffe the chorus of the green tree-frogs makes evening hideous. But with all this noise, there seems to be no fighting.

Among reptiles we find not only varieties of crests and pouches peculiar to the stronger sex, but battles between rival males. The huge male tortoise of the Galapagos Islands utters a "bellowing noise" in the pairing season, which, however, does not seem to be very loud. Male alligators have been seen splashing and roaring in an ostentatious way round a female, but it is apparently unknown whether they fight with one another. However, some kinds of lizards are undoubtedly pugnacious. Two adult males of *Anolis cristatellus*, a South American arboreal species, "rarely met without a contest."[2]

There has been a boom in birds lately that ought to have made the main facts familiar, so that only a very brief review of them should be necessary. Their battles everyone knows of; the noisy scrimmages of house sparrows, the tragic encounters of game cocks, the stately sparrings of ruffs (*Machetes pugnax*) that are said, however incredibly, to end like Pickwickian quarrels in nobody being any the worse. Feathers are admirably adapted for colour display. The most beautiful colours of all, the iridescent, are produced without the aid of any pigment and cannot be said to tax in any way the bird's fund of vitality. But in such birds as the argus pheasant and the bird of paradise the ornamental plumes are of such dimensions as to impede flight, to say nothing of the strain that the annual production of them must put upon the vital resources. In many species song takes the place of colour, and it is seldom that we find both highly developed in the same

[1] Figures of very brilliantly coloured fish of the Plectognathi group are given in Mr Savile Kent's *Naturalist in Australia*.

[2] Quoted by Darwin, *Descent of Man*, vol. ii. p. 32.

bird. The female has, as a rule, but little share in the splendour of plumage, and hardly an echo of the song.

Mammals have comparatively little to boast of in the way of colour, very probably because hair is far less suited to its display than feathers. Still, the male sex has some special embellishments. With monkeys, as with men, if there is a well-developed beard, it is found only in the male. When there is any difference of voice, it is the male's that is the more powerful. These, however, are minor distinctions. Selection among mammals is mainly by battle and the secondary male characters are superior strength and powerful horns or tusks.

Most of the information given above and an enormous mass besides, as to the difference between the sexes in the arthropods and all that rank above them, is to be found in Darwin's *Descent of Man*, in which sexual selection is discussed at great length. The book is a mine of facts and proves, as do his other works in support of the origin of species, that he never for the pleasure of theorising desisted from the patient collection of materials.

Need of a cumulative principle

It will hardly be disputed that a greater tendency to vary is characteristic of the male sex. This variability insures that there are variations ready to hand, raw material in plenty. But something more is wanted. How is it that so much that is wonderful in the way of weapons and ornaments has been manufactured out of this? We have to find some cumulative principle which could gradually build up structures so large and elaborate.

Darwin's theory

It is generally recognised that selection by battle accounts for the evolution of spurs in birds and of large canine teeth and horns in mammals. But when we come to such male adornments as the fine plumes of the male bird of paradise, we broach a subject around which controversy still continues. Darwin contended that the female exercised a choice. The male, whose antics were the most striking or whose endowment in the way of plumage or voice was the richest, found favour as a suitor. And so in each generation the most brilliant or the best singers were selected. To make good his contention, he had to show (1) that hen birds had at least so much eye for colour and form that they could distinguish a

brilliant suitor from a dull one, and one of their own species from a "foreigner"; similarly just enough ear to know a fine song from a poor one, and among the songs of many species to recognise that of their own; (2) that there was reason to believe that the female did exercise a choice.

As to the first point much nonsense has been talked. It has been said that we have to assume a subtle æsthetic sense in the hen-bird enabling her to appreciate each delicate shade of colour, every nicety of pattern, and the refinements of music. No such appreciation, however, is necessary to the theory. What is assumed is merely the power to distinguish between a good show and a poor one, or between two good shows that are markedly different, whether appealing to the eye or to the ear. This demands, no doubt, some development of the colour-sense or of the sense of hearing. But this is quite different from æsthetic appreciation. It has been said that female taste is proverbially fickle, and would consequently guide evolution, now hither, now thither. But we know that coloration is primarily a recognition mark, and song a call note. Natural Selection, therefore, would check the vagaries of female taste. The first necessity for the male is to convince the hen-bird that he belongs to the same species as herself. Only after that will courtship proceed. If the hen-bird is capable of knowing a recognition mark or a call note—and no one disputes this—then she has all the colour-sense and musical sense that is required.

If we go to the farmyard for evidence, we shall find some that is liable to misinterpretation. An old cock, scarred and battle-stained, is preferred by the hens before his handsome young rivals. This, after all, is not a very damaging fact. The hens saw and recognised his beauty before a series of fights marred and draggled it. In polygamous species at any rate, what finds favour is the combination of martial prowess and beauty. The former charm still belongs to the battered bird we are imagining, the latter is still fresh in the memory of his admirers. That he should be accepted is no more wonderful than that a scarred soldier returning from a campaign should be preferred to the best-looking man in London.

What evidence, however, is there that the hen-bird does exercise a choice, and does not merely submit to the stronger or to the first-comer?

Darwin has collected some; it must be owned that it does not amount to very much. On such a subject how could much be expected in the way of direct evidence? But there is much that makes it *a priori* probable that personal preference very commonly comes into play. In the first place, we must remember the comparative indifference of the female and the power that she in many cases has of escaping from her admirers. It is known that they often present themselves in numbers. The conditions, therefore, are such as to stimulate suitors to a competitive display. They have often, it would seem, to excite desire and personal preference, and unless we assume that they succeed in winning some sort of affection, the habit of pairing is very difficult to explain. It is impossible to watch the mutual caresses of pigeons that have paired without being convinced that they are fond of one another, and there is further evidence in the fact that, when they have reared their young, they do not seek new mates but continue paired. The marvellous love antics of cock birds, their frenzied dances, their displays of plumage, their ecstatic songs are all means of rousing the hens from apathy. It has been urged as an argument against Darwin's theory that a peahen will stand by in utter indifference during the self-display of the peacock. But if even that does not always charm her, what chance is there for a less brilliant suitor? Anyone who refuses to follow Darwin here must, when he sees a peacock in his glory, hold that the trouble, the colour, the plumage are so much waste or worse than waste. This is surely an unreasonable attitude, when we know that adaptation is the rule in the organic world. And in this case the object in view, the bringing of the sexes together, is of paramount importance, and since the object is attained somehow, why not by means of the adornments of the males, which are useful for no other purpose, and which he visibly makes the most of at the time of courtship?

Professor Lloyd Morgan quotes from American observers some

very telling evidence that brilliancy of plumage has a great deal to do with the question of mating:—

"The case of apparent sexual selection which I mentioned to you this evening came to my notice in the spring of 1877, when I was collecting birds at St Mary's, Georgia. Finding a pair of summer tanagers (*Pyranga rubra*) in an isolated grove of pines, I shot the male. Visiting the place a day or two afterwards, I found that the female had another mate, which I also killed. This was repeated, until, in about a week, I had secured in all four or five males—I cannot remember which. These males when arranged in the order in which they had been killed formed a graded series, of which the first was an unusually richly coloured bird, the last an exceptionally dull one, the others representing various intermediate shades or stages of coloration. I was confident then—and I fully believe now—that all these males were successively mated to one and the same female: but my only evidence of this was that I never saw more than one female in this locality, and that on the different occasions she looked and acted like the same bird."[1] The second case bears out this view: "About the date you say (*e.g.* 1868 or 1869) I shot three male redwings in one meadow (at Newtonville, Mass.), all over one nest. The first was in high plumage, the second less so, the third quite young, and I left with the female a young bird of the previous year, judging by the absence of red on the wing."[2]

I don't know how evidence of this kind is to be got over. A few more such cases well established, and the matter would be set at rest.

A difficulty in Darwin's theory

There is a difficulty in Darwin's theory of Sexual Selection which has never, I believe, been satisfactorily dealt with. The plumes of the peacock are so monstrously large that they endanger his life. He can fly well with the wind, and peacock shooting is considered good sport. But short flights seem to be all he is capable of, and in some parts of India the natives take advantage of this. "Peafowl run very fast, but the old cocks,

[1] Quoted by Professor Lloyd Morgan from Mr William Brewster of Cambridge, Massachusetts, in *Habit and Instinct*, p. 221.

[2] Quoted from Mr Maynard, *Habit and Instinct*, p. 222.

burdened with tails six feet in length, are poor flyers; and I have frequently seen my men run them down during the hot hours of the day by forcing them to take two or three long flights in succession, in places where they could be driven from one detached piece of jungle to another." [1]

The plumes of the Argus pheasant, too, however beautiful, must be very cumbersome. Moreover, hundreds of examples might be found in which the plumage of the male, though it does not impede flight, is too brilliant for safety. How is it that Natural Selection tolerates such a thing? It would seem that Sexual Selection, which should be only a subordinate, has somehow got out of hand. But if we reflect upon the matter, it is clear that this cannot be so. Natural Selection, if the principle is a true one, must be at work everywhere, though not creating, yet controlling. The force which thrills through all living organisms causes them to burst forth into all manner of developments, some fitted to the environment and some unfitted. Natural Selection presides as the great regulator. This is the Darwinian theory, and Darwinians ought to be able to show that in any organism all the characters are serviceable or at least not harmful. This brings us back to the plumes of the peacock, the bird of paradise, and the Argus pheasant.

M. Stolzmann's theory

M. Stolzmann,[2] a Pole who, happily, writes in French, is of opinion that the large excess of males in many species of birds is a disadvantage, since the bachelors are perpetually disturbing the hens upon their nests, and that Nature, therefore, strives to reduce the number by adorning them with plumage that is the very reverse of protective, and by encouraging a system of internecine warfare.

A well known fact might seem to support this remarkable theory: gamekeepers find that if they keep down the number of cock pheasants they have more young birds; with grouse (*Lagopus scoticus*) the same thing has been noticed. But we cannot from this draw the conclusion that Nature makes the mistake of allowing an excess of cock-birds, and then proceeds

[1] Hume and Marshall's *Game Birds of India*, vol. i. p. 88.
[2] *Proc. Zool. Soc.*, 1885, p. 421.

by a cumbrous and costly process to reduce their numbers. What we have to show is first that the individual, even if his safety is endangered by his grand plumage, yet has, because of it, a better chance of leaving offspring, and secondly, that the species gains by the system.

The explanation, I believe, is really quite simple. The fine plumes are found in their highest development in polygamous species, and this fact is the key to the problem.

The explanation of the difficulty

Let us imagine a polygamous species; in which there are sixty males, thirty of whom are burdened with brilliant plumage, while the attire of the other thirty is less burdensome and less bright. Let us further imagine that half of the brilliant thirty lose their lives through the dangers their beauty brings with it, or through their pugnacity. The surviving fifteen, however, will be the fathers of practically all the next generation, the dull thirty being driven out of the field or being rejected by the hen-birds because of their dulness. Thus, though a particular individual might fall a victim to over-ornamentation, yet the brilliant as a class would have an advantage over the dull, in the sense that they would have more offspring. This must be the case, since a bright-coloured bird will have a good chance of being the father of many, whereas there are heavy odds against a dull-coloured one having any progeny at all. To simplify the problem I have imagined that there are thirty of each sort. In reality they would not, of course, be divisible into classes so definite, but there would probably be a descent by nice gradations from the brightest to the dullest. This, however, does not affect the working of the system, the result of which must be that the number of young a cock-bird leaves behind him will be roughly in proportion to the development in him of the secondary male characters. *The species too, so far from being a loser, will gain.* In each generation the finest of the males will be the sires of practically all the next generation, Sexual Selection thus greatly intensifying Natural Selection.

We must assume that in every case general vigour accompanies fine plumage. And this all the evidence goes to prove; the most brilliant are the best fighters also. In all polygamous

Fine plumage the concomitant of vigour

species there are fights among the males. The peacock, though it might seem to be no better than a lay figure for showing off a costume, is known to fight desperately. Generally speaking, spurs are part of the equipment of the polygamist. It is true that the ruffs (*Machetes pugnax*) have none, and their sparrings are said not to be fights but only a stately make-believe. But they are also said to be polygamous, and it is difficult to reconcile these two statements. There is strong reason, it is true, for believing that the hens have preferences, but that this alone should lead to polygamy is hardly conceivable. We are driven to assume that it has its origin in the pugnacity of the cock-birds. It follows, therefore, that, however extravagant their plumage, it is always the concomitant, or rather the expression, of high spirit.

Monogamous species

As yet I have said little about the species in which pairing is the rule. In them, too, we often find that the cock is much brighter than the hen, and has a brilliancy of plumage which, it might have been thought, Natural Selection would not have allowed. There is much evidence in support of the view that in most species of birds the cocks greatly outnumber the hens. If this is so, a cock-bird is confronted with one or other of two dangers; through dulness and the concomitant want of vigour he may remain unmated, or through excess of brilliancy he may meet an untimely death. In those species where the latter danger is the smaller of the two there is likely to be a further evolution of masculine beauty; where the former counts for little there is likely to be no further embellishment.

Where the males have no superiority in numbers, still the brighter and more vigorous of them will pair with the more vigorous females, and will leave more numerous and finer offspring. Thus here too the same system will work well. But Natural Selection will obviously put a greater check upon extravagance of ornamentation, since the gain to the species from competition among males is less where the supply does not exceed the demand. The excess is clearly greatest in polygamous species, and it is there that we find ornamental plumage most highly developed. The following formula is very probably

not very far from correct; the brilliancy of the males is in proportion to the excess of the supply. But in many species it is quite possible that the numbers of the sexes are equal, and these the formula does not take into consideration.

Recapitu ation

I have now shown, or tried to show, that Sexual Selection, when its working is rightly understood, will account satisfactorily for the secondary sexual characters, even the most extravagant. No other theory attempts to explain the steady accumulation, generation after generation, of each advance in brilliancy. Such an exceptional case as that of Rhyncaea, the Indian Painted Snipe, where the hen is far more showy than the cock, presents no difficulty, if in this genus there is a preponderance of hen birds. This would naturally lead to fights among them, such as do actually occur, and competition for the males. Even if the numbers are equal, yet the system will lead to the best pairing with the best. In any case the species profits by a system which puts a premium upon vigour.

Not only are secondary sexual characteristics accounted for by Darwin's theory, but the supremacy of Natural Selection is not interfered with. Individuals may be sacrificed, but the species is the gainer. Where polygamy exists the system works most freely, and there its services to evolution must obviously be great; it must lead to an increase of vigour since in each generation, only the very pick of the males, leave any progeny behind them.[1]

Dr Russe Wallace

I must now pass on to the consideration of Dr Russel Wallace's theory that male ornamentation is the "natural product and direct outcome of superabundant health and vigour."[2] The males in some species are, he maintains, so vigorous that they are exempted from the operation of Natural Selection. It is very strange that Natural Selection should be thus attacked by one of the two great originators of the theory, and that the Darwinian hypothesis should

[1] Among hive-bees only one out of hundreds of drones mates, since there is only one queen. But the mating always takes place on the wing during the nuptial flight, and it is quite possible that by this system one of the most vigorous drones is selected.

[2] *Darwinism*, p. 295. A similar view is held by Geddes and Thomson, see *The Evolution of Sex.*

receive such a blow in a book named after Darwin as a testimony of respect. For the thrust, if only driven home, must prove mortal. A great principle, if it operates only partially, must be unsound. A law of gravitation to which some substances were subject but not others would be a subject for ridicule. And no less so in the case of Natural Selection: if it is a true principle, it must operate wherever life is: it must decide the fate of every organism and of every important part of every organism. Each structure must pass muster either as definitely serviceable or as too insignificant to be harmful.

I have called attention early in this chapter to the fact that the male sex is characterised by energy and variability, while the female sex is less variable and comparatively sedentary. This differentiation seems to date from the time when sexual dimorphism originated, and it is the tendency of the male to vary, which Sexual Selection has turned to account. It was there before any of the conspicuous secondary characters of sex had been evolved. Thus much may be conceded. There was material ready to work upon. There was all the vigour which Dr Russel Wallace assumes. But something more than this is wanted, some principle that will account for the accumulation of favourable variations as they arose. And none has been suggested except Sexual Selection.

Sexual Selection co-operates with Natural Selection

Moreover, Sexual Selection rightly understood, does not conflict with Natural Selection, but leaves it in its supreme position. The secondary male characters, even if they lose some strong individual his life, are yet advantageous to the species. For by captivating the hen birds, they help to bring it about that the very cream of the males are the sires of all the next generation. Thus vigour—and not in the form of showiness—is transmitted to the females, who have to rear and defend the young. The courage with which a mother bird defends her nestlings is derived from the line of pugnacious males from which she is sprung. Thus the species gains by what might appear mere dandified adornment and a mere fire-eating spirit.

Natural Selection, as I have shown in the preceding chapter, can only bring about further evolution when there is a change of

environment. A bare superiority to existing conditions is the utmost that can be expected from its operation. But Sexual Selection is not thus limited, or, to put it more correctly, the males by their pugnacious rivalry make an artificial environment for each other, and this may be merely a more exacting form of that to which the species in general is subject. When this is so, there will result, not something in itself useless, such as ornamental plumage, but an improvement in some organ on which the species depends for existence.

The giraffe's neck

Let us see how this applies to the old problem of the giraffe's neck. If we try to account for it by Natural Selection working unaided, then we have to assume a series of droughts. Each of the series, we must believe, was more severe or more prolonged than that which preceded it. Either, then, at each recurrence, the leaves of taller and taller trees (taller because more deep-rooted, and, therefore, better able to stand the drought) were the only food available, or else, each visitation lasting longer than the last, the shoots were eaten off to progressively higher levels. It is very difficult to believe that this ever happened; but if Natural Selection brought about this elongation of the giraffe's neck, we must postulate for each increase in length a corresponding increase in the altitude at, and not below, which food was obtainable.

But Sexual Selection may help to get us out of what would otherwise be a tight corner, if we can show that there are fights between the males, and that length of neck and fore-leg somehow gives an advantage to the combatants. Now the male giraffe in his own habitat is by no means the mild statuesque animal that we are familiar with in the Zoological Gardens. On the contrary he uses his short horns with great effect. As to his height, it does not seem likely that an extra foot or half foot would be of any service in an actual encounter. But indirectly it may be of the greatest assistance. On the occasion of a drought, the shorter members of the herd might manage to survive, being able to obtain just pasturage enough to live on, but the taller would be decidedly better fed. Height would, therefore, be the concomitant of vigour, and the tall

males would drive off the shorter ones, who, except that a meagre diet had reduced their strength, might be their equals or superiors. The fact that the males have a superiority in height supports the view that Sexual Selection has co-operated with Natural Selection. Superiority of strength and stature is not throughout the animal world the privilege of the same sex. Among hawks the hens are much larger than the cocks, the female spider in many species is a giant compared with her partner. What superiority in height the male giraffe has, we must attribute to Sexual Selection. The fact that the superiority is no greater is what we have to account for. Now, it is known that when a particular character is developed by Sexual Selection, it is often transmitted in a modified form to the other sex, unless it involves a danger. Dr Russel Wallace has shown that the brilliant plumage of the cock-bird is often shared by the hen, if, owing to the nesting habits of the species, it does not bring her into much danger. In the case of the giraffe, the masculine character, length of neck and fore-legs, so far from being a danger is an advantage, and therefore we should expect an approach to equality in the sexes.

If Sexual Selection has worked in the way I have suggested, we need not assume so many recurring famines, since at each recurrence it was necessary for a male, if he was not to be eliminated (discomfited, that is, and driven from the herd), not only to be just tall enough to keep life in him by reaching the lowest food available—which is all that Natural Selection pure and simple would insist upon—but tall enough to get food in plenty and so hold his own against tall and well fed rivals.

Migratory birds

One more example to show how Sexual often co-operates with Natural Selection. In the spring migratory birds that have been wintering in the south begin to think of their northern home. A strong impulse takes possession of them. They set out and put forth all their powers. It is a race and there are prizes. The best flyers among the cock-birds arrive first, and if they are songsters they make the woods ring with their pealing notes. If they are but twitterers like the swallows, their flying to and fro announces their arrival Before long,

the hen-birds that are strongest on the wing arrive and mate with the most vigorous cocks, attracted by their trumpet notes, or by whatever other modes of advertisement they may have. Thus the strong pair with the strong, while a male who, through inferior wing power arrives late, has to mate with a weakly belated hen-bird. By this system the young birds of the year will be to some extent divided into two classes, the strong and the weak, and the elimination of the unfit by Natural Selection will be facilitated. But this is not all. Sexual Selection working thus is able to bring about more than the bare superiority to existing conditions which is all that Natural Selection, if it works unaided, can achieve. The migrants under this system can fly more than just well enough to make their two annual journeys. They have a superfluity of wing power, and if any exceptional emergency arises, such as a storm that they have not been able to foresee, then the vigour Sexual Selection has given them may enable them to weather it. Or the environment may become permanently more exacting: the birds of prey may become keener of sight, more unerring in their swoop. Then the strength that Sexual Selection has conferred upon the small bird may stand him in good stead.

Here I may recall what I said in the previous chapter about the crises that occur in the lives of all animals.[1] Their structure must fit them to stand the severest trials to which they are likely to be subjected, such as severe cold or the attacks of formidable enemies. Such trials will come as occasional crises, and during the intervals they will have a superabundance of vigour. But Sexual Selection may endow them with a vigour even beyond what the most severe crises may demand. It might, in fact, if systematically carried out in a species ennoble every structure and every faculty quite independently of Natural Selection. The individuals thus ennobled would form the aristocracy of the race. This is no doubt what actually to some extent happens, but Natural Selection soon intervenes and makes short work of the common herd. There are more of them than there is room for, or an unusually severe crisis comes, and the aristocracy alone remains.

[1] See pp. 72-77.

Sexual Selection plays the part of a skilled breeder. It mates the best with the best, while Natural Selection only fixes a survival line and lets those who come above it pair indiscriminately —obviously an inferior method. But while we admit this we must bear in mind that in wild nature Sexual Selection is always subordinate to Natural Selection. No characters are developed by it that are injurious. Even the plumes of the peacock are only a contrivance, so to put it, for increasing the vigour of the species. For it is partly owing to these charms, if Darwin's view is correct, that only the most vigorous males leave any offspring behind them.

Circumstances under which polygamy arises

In species where polygamy obtains, the males are very pugnacious and fight among one another. The cock of the farmyard must depend for his supremacy mainly on his own prowess, however much feminine admiration of his decorations may assist him. But male pugnacity does not as a rule lead to polygamy. For in most species of birds, the cocks are very fond of fighting and the habit of pairing continues in spite of it. It may often happen that no blood is shed and that the vanquished leaves the field only half humbled and ready as soon as opportunity offers to reassert his claim. This leads us to inquire as to the weapons of offence. Among the polygamous species the males are generally armed with spurs. The capercaillie (*Tetrao urogallus*) and the blackcock (*T. tetrix*) have none, yet their fights are no mere bloodless sparrings; they have beaks and claws to fight with. It is among the polygamists, with the doubtful exception of the ruffs, that the fights are most desperate and most deadly. It would seem that the pugnacious tendencies are somehow held in check where pairing has become the rule.

If we turn to mammals we find the facts are the same. Even in what are accounted timid species, male pugnacity breaks out in the breeding season. Male hares have been known to fight till one of the combatants has been killed. But it is among the polygamists that the fighting propensity is strongest. Everywhere there is the same tendency to masculine self-assertiveness, but in most species an imperious necessity keeps it in check. The young must be fed and defended; that is the supreme need

with which nothing must interfere, and in most species one parent alone cannot undertake the task. When young birds are "precocious," *i.e.* able to run about directly they are hatched, and, under maternal direction, to pick up food for themselves, then polygamy becomes general. The moor-hens might seem to be an exception to the rule, since the young when born have the use of their legs and faculties, yet both parents and even their brothers and sisters of a previous brood help to rear them. But this exception helps to prove the rule, since the "precocity" of the moor-hen does not enable him to forage under water. We may rank the moor-hen, therefore, with the species in which the young are born helpless and remain long in the nest before they venture forth into the world. And it is in such species that we find that the cock is a faithful husband and helps the hen in foraging. The mallard is attentive to his mate during at least part of the time of incubation. As soon as or before it is over, his moulting begins and, his power of flight being lost for the time, he retires for safety to the water. When the young ducks hatch out, the mother unassisted tends them. However, as they are undoubtedly "precocious," what we have to account for is the persistence of monogamy. Probably the hen has to be long absent from the eggs in order to obtain sufficient food and then the mallard may sit in her place. When ducks are domesticated the food difficulty is removed and they readily take to polygamy. Partridges are no exception to our rule, for the cock-bird helps much in tending the young and protecting them from birds of prey.

Among mammals the principle is the same. The young of the great ruminants are able to browse on grass or young shoots of trees as soon as they are weaned. And among ruminants polygamy exists on a very large scale. Among the terrestrial carnivora, on the contrary,[1] the lion is believed to be the only polygamist, and even he sometimes lives with only one female, never, apparently, with more than five. Here, as always, the system is maintained by fighting, and his lordly mane is use-

[1] See Darwin's *Descent of Man*, vol. i. p. 268. Much information on the subject of polygamy among animals is to be found in this work.

ful chiefly as a defence against rival lions who, if we except man, are his only formidable foes. Among the carnivora in general, monogamy prevails for a reason that is easily intelligible. Though the young are not born helpless like human infants, yet they are quite unable to hunt and kill for themselves. And this has curbed the polygamous tendency that must otherwise have been fostered by a warlike disposition and the possession of splendid weapons. The seals, unlike the terrestrial carnivora, are great polygamists. The males fight desperately, and the doughtiest fighters collect around them harems that outnumber even those of the ruminants. Here the explanation must be the same. The young seal is able to catch fish for himself almost directly he is weaned, with the help of a little teaching and encouragement from his mother.[1] He preys upon creatures comparatively low in the scale, not, like a leopard or a cheetah, on animals protected by intelligence as well as speed.

The rodents, with the possible exception of the common rat, are monogamous. The young, born helpless, are hidden away in holes or nests, and must have their food brought to them.

Of the many species of monkeys, some are strictly monogamous, while among others a male has several wives. Here, as in other cases, I believe it will be found that the tendency to polygamy is only kept in check by the difficulty of feeding the young. When the difficulty is but slight, male self-assertiveness soon puts an end to the pairing system. Polygamy, in fact, is tolerated by the law of Natural Selection in those species, and those only whose habits and environment render it possible. When it is possible, it is also beneficial, since all but the few most vigorous males are eliminated. This statement must, of course, not be taken as referring to human society, where the conditions are very different.

[1] See Mr Barrett Hamilton's paper on *The Habits of the Northern Fur Seal* in *Natural Science*, July 1899. On p. 41 he describes the education of the young, such as it is. There is apparently no need for much.

Chapter VI

ISOLATION

I

ISOLATION OF ANIMAL SPECIES

DARWIN never appreciated at its full value the importance of isolation, believing firmly that divergent evolution, the splitting of one species into several, might take place without it. His failure to grasp this seems all the more curious when we reflect that he always thought of Natural Selection as a great breeder of animals, and no breeder would dream of dispensing with isolation. The breeder picks out the animals that show in the highest degree the points he wishes to develop, and keeps them apart from all the rest. If he does not isolate his selections, he must kill off the unselected, and there will only be one breed as before, though a different one. If Natural Selection works without isolation, only monotypic evolution, *i.e.* the production of one new species, can result. All the rest must be eliminated, or else a new variety, as it arises, will be swamped by intercrossing with the parent species. It was the work of Romanes to emphasize this fact and make it clear. Dr Russel Wallace divides evolutionists into those who consider isolation "a very important factor" and those who consider it "essential." It is difficult to see how it can be anything but essential, and I think the difference of opinion is due to the fact that isolation, when not due to some definite, easily recognisable barrier, is not counted as isolation. It is important, then, to see what various forms of it are in operation. First, there is geographical isolation. The dodo on his island afforded a good example of this: it was owing to his living a life apart, where there were no carnivorous mammals to make flight a necessity, that he lost his

Importance of isolation

wing power. Had there been constant fresh arrivals of birds of his species, intercrossing would have maintained his power of flight and enabled him to escape from the conscienceless sailors who exterminated him. Among the higher animals isolation is, *probably, very often due to preference. Some difference in colour or marking arises by which sympathy is bred, and then those in whom this marking is found, herd together and form a race that may in time develop into a species, kept apart by what* we may call clannish isolation. Thus recognition marks are of the utmost importance, and those who have made light of them cannot have realised the importance of isolation. Call notes, the cries peculiar to a species, answer the same purpose as recognition marks, and are often alternative to them. Of this kind of isolation I shall give some further account, and also of another which operates very generally in the vegetable world and probably among the lower animals. This latter form is sterility between species, due to differences in the reproductive cells. We must regard it as arising simultaneously with beneficial variations and protecting them from the effects of intercrossing. Among the higher classes it is probable that clannish isolation often replaces it, but without numbers of experiments it is impossible to speak positively. And experiments are very difficult; if animals of two different species are crossed, there may be perfectly healthy offspring, and yet the species may be intersterile. For the progeny may be mules and incapable of continuing their race. It is, however, beyond a doubt that intersterility among wild species is by no means invariable. Our domestic cattle are descended from various wild stocks. At the Zoological Gardens some success has been attained in crossing the bison with the yak and the gayal, and it is much to be regretted that such experiments have not been more frequently made and carried out more systematically.

Clannish isolation

Inter-sterility

There must be isolation in some form. This is true though prepotency is an undoubted and very important fact—though one parent is often able to transmit his or her characteristics while those of the other are but little represented in the offspring. Continual intercrossing with ordinary members of the species

must greatly reduce a character that shows itself at the outset only in one individual, however prepotent. Stability cannot be maintained without isolation.

However sound a principle may be, it is possible to make too much of it, to make it a hobby and ride it to death. *This was done by Romanes whose persistence converted the scientific world to a belief in the importance of isolation. It is with regret* that I say anything that may seem depreciatory of a man who showed throughout his life such a devotion to science, so much zeal for truth, such patience in the search for it. It cannot, however, be denied that instead of putting isolation in its proper place as one of the conditions without which species could not have arisen through Natural Selection, he dethroned Natural Selection and made isolation supreme. Natural Selection, he maintained, was only one form of isolation, for all those that were not selected died off. Mr Gulick also, his supporter, put isolation on an equally high pedestal, having been led to do so by his study of the land molluscs of the Sandwich Islands. There are no less than three hundred species in this small area, nearly all of them belonging to the same family. In valleys on the same side of the mountain range and having the same vegetation, the molluscs belong nevertheless to different species. These are very remarkable facts, and the conclusion Mr Gulick has come to is that Natural Selection cannot account for them, since we have separation into species where the conditions are similar. These snails, he maintains, have not been modified in each valley to suit their environment, but differences have arisen, without reference to environment, through isolation. So far I think he makes good his point, and Dr Russel Wallace's answer is unconvincing. It consists mainly in an appeal to ignorance. "The conditions," he argues, "in each valley may be different though the difference may be indiscernible to us; and the fact that the mammals and birds of Ireland are the same as those of Britain, shows that isolation alone, without difference of conditions, leaves species as they were." As to this last point it is well to remember that recently it has been shown that the Irish stoat has constant markings that differentiate it from the English stoat and

Romanes and Mr Gulick

Land molluscs of the Sandwich Islands

it has in consequence been elevated to the rank of a separate species (*Putorius hibernicus*).

I have studied the lengthy and somewhat pedantic paper on "Divergent evolution through cumulative segregation"[1] in which Mr Gulick has expounded the theories that he bases on his investigation of the Molluscan Fauna of the Sandwich Islands. And though the actual conclusions seem to me to a great extent warranted by the evidence, yet some of the sounding phrases would, if taken literally, mean a great deal more than they are, apparently, intended to mean. Such are "cumulative segregation," "intensive segregation." It turns out, after all, when we come to the facts, that the words "cumulative" and "intensive" are misapplied, meaning no more than that species are multiplied, or subdivided into many, the differences between all of them being slight. They still belong, all of them, to the same family or sub-family, the Achatinellidæ. The snails have somehow been transported to new valleys, and, probably because there were no new arrivals for a long time, intersterility with other varieties has arisen and so a new species has been formed. This repeated division and sub-division till one species has become three hundred or so, to say nothing of numbers of varieties, is a fact to stimulate reflection. And I think the conclusion that we must draw is, that slight variations that arise may become fixed, when there is isolation, without the help of Natural Selection. But there is no cumulation. The variations have not been piled one upon the other till the three hundredth species bears little resemblance to the first. There seems to have been no thought of putting any of them in a separate family. But if evolution is a fact we have to account for such things as the gradual development of a rudimentary notochord into a backbone, of a mere pigment spot beneath the skin into an eye, of a one-celled animal into a man.

To these problems isolation, acting alone, has noth'ng to say. The kind of work it has accomplished among the molluscs of the Sandwich Islands is the same, only on a large scale, as might be achieved if our many varieties and sub-varieties of brambles

[1] Linnæan Society's Journal, vol. xx (1886-1890).

were all kept apart so that intercrossing might be impossible. Then we might, possibly, have a very large number of definite species, but they would still belong all of them to the genus Rubus.

All this applies to the position taken up by Romanes. He failed to see that isolation alone had no cumulative power, whereas Natural Selection as the generations pass, piles up, specialises, makes complex, till at length a low organism becomes a high one. The concession that I have made as to the powers of isolation acting alone is no surrender, I believe, of an important Darwinian position. It is merely a recognition that unimportant variations, when there is no crossing with other varieties, may remain constant or nearly so, not encouraged and not eliminated by Natural Selection.

There is another question connected with isolation which I shall not discuss at length because I think there is no need to reopen it: can physiological selection, as Romanes called it, *i.e.* isolation due to differences in the reproductive cells, produce new species, though unaccompanied by any beneficial variation? As far as I can see, the answer must be an emphatic No. If a few members of a species, say twenty, are fertile only *inter se* and not with others of the species, they will run a great risk of leaving no offspring, for, being but a scattered handful among a crowd, they will not be likely to pair together. But if some peculiarity in the reproductive elements expresses itself in a beneficial variation, then it is clear that a new species may be founded. The belief that reproductive divergence alone can make species must, I think, have its ultimate origin in the common teleological fallacy. We wish to account for species, and, therefore, we put Nature in our own position as if she were anxious to divide up the undifferentiated herd and keep them in different folds, so that specific differences may be fostered and developed.

Physiological selection must be rejected. But we cannot but believe that variations that have survived have been protected by isolation in some form or other. This view does not dethrone Natural Selection; it merely makes isolation one of the necessary conditions, if Natural Selection is to multiply

species. Natural Selection is the regulating *principle that* guides the course of evolution; isolation is an indispensable henchman. And since evolution can make no headway without it, we might expect to find the means of isolation developed to the very utmost. We must be careful, however, ourselves to keep clear of the teleological fallacy into which Romanes seems to have fallen. We must not say that species resort to every possible expedient in order to keep themselves apart, as if divergent evolution were an aim in view. Putting the matter more correctly, we must distinguish two cases. In the first a group, marked by characters that give it an advantage, survives, because protected by isolation: it does not lose its advantages through the swamping effects of intercrossing with individuals not similarly endowed. In the second case there is, perhaps owing to geographical isolation, a separation into groups which differ from each other very little in habits or in structure so far as observation can detect. When any of the allied groups come into contact, the geographical isolation, for whatever reason, ceasing, fusion may follow. On the other hand, the clannish spirit that is often of service quite apart from the question of isolation, may prevent it, and if so, recognition marks and cries will under the new conditions gain in importance. There may also have arisen, if not sterility, yet comparative infertility between the species in question and its allies. Those individuals that fall away, therefore—those that have not the distinctive characters well marked or who fail to recognise them in others and, therefore, mate with "foreigners"—will, probably, leave fewer offspring. Once a species is formed, all tendency to disintegration is likely to be checked.

Recognition marks All wild animals seem to have some means of recognising others of the same species. We find many groups characterised by distinctive coloration that must make recognition easy and many by special cries that answer a similar purpose. On the subject of recognition marks a great deal has been written by Dr Russel Wallace, and if their importance is under-estimated by many naturalists, it can only be through a failure to realise the conditions—to realise that species have survived as species

only when they have had some means of keeping themselves apart. And if a group is to keep apart, its units must have the power of holding together, since, however necessary the isolation of the species, an isolation of units would be fatal.

Difficult as it is, from the nature of the case, to obtain direct evidence of the working of the system of recognition marks, there is nevertheless some. Cattle certainly notice colour differences, and when allowed to run wild they will sometimes separate into herds, which, except in respect of colour, have apparently no distinguishing characteristic. Again, it is a remarkable fact that among wild animals, except for very slight deviations, bilateral symmetry in coloration is always adhered to. Whereas in many of our domestic cows the two flanks often present quite a different appearance. Such vagaries are possible in the tame breeds where man, instead of nature, selects. Among wild animals they must occasionally arise and be rejected. Very possibly an instinct, that serves to preserve recognition marks as the cement of the breed, prompts wild cattle to drive such monstrosities from the herd.

Isolation among birds

Birds, I think, enable us better than any other class to understand this subject. When they, or rather their progenitors, were still in a reptilian stage, with very limited powers of locomotion, there would not be great risk of their failing to find each other. Even where their swimming powers are great, it is difficult for reptiles to wander far. They cannot frequent the open sea, since they must be within reach of the land. In the Nile, as they swim up and down, crocodiles must meet each other, or they can find their fellows as they lie basking on the banks. Amphibians also have limited powers of locomotion. For them, as for reptiles, the wide seas are an impossible habitat, since, being air-breathers in their mature state, they must, unless they have some very special adaptations to aquatic life, be able to land when they need rest. This remains a fact, though frogs can live at the bottom of a pond in a torpid state during the winter, breathing sluggishly through the skin. To reptiles and amphibians, then, call-notes cannot be so important as to that class whose powers enable them to range over the whole globe. Nevertheless, frogs have a very

considerable activity, and find their way from pond to pond and stream to stream. Accordingly, among them we find the call-note largely developed among the males.

When the great evolution from the low reptile world took place, the conversion of the fore-limb into a wing was the greatest change. But among the further changes necessitated by it was the development of means of recognition, whether addressed to the eye or to the ear. It follows, as a matter of course, that both eye and ear had to grow in keenness. In deciding whether a particular feature is a recognition mark, or whether it serves some other purpose, or whether it is merely due to correlation with some useful structure, and itself serves no purpose at all, we may make very great mistakes. When Dr Wallace adopted the view that the white tails of rabbits were "signal flags of danger," some people were struck by the ingenuity of the suggestion, others laughed at it as absurd. In any case, we may regard it as proved that the males in many species in widely separated classes of animals call to the females, and though the case for recognition marks appealing to the eye is not so strong, yet it is by no means weak.

Distinctive song and distinctive plumage often alternative

Myself, I attach great weight to the following argument. In birds that are plain-coloured, with the frequent consequence that several species are very nearly alike, we find, as a rule, a characteristic song developed in each species. On the other hand, when the plumage of closely allied species affords an easy distinction, the songs and call-notes are often very difficult to distinguish. The Warblers are a very plain race, and among them the power of song is brought to great perfection. Two well-known Warblers, the Chiffchaff (*Phylloscopus rufus*) and the Willow-wren (*P. trochylus*) are very much alike, so that, without a very close inspection, it is difficult to tell them apart. But directly the song of the two is heard, the doubt is removed. The Wood-wren (*P. sibilatrix*), the Reed-warbler (*Acrocephalus streperus*), the Marsh-warbler (*A. palustris*), the Sedge-warbler (*A. phragmitis*), the Grasshopper-warbler (*Locustella nævia*), the Blackcap (*Sylvia atricapilla*), the Garden-warbler (*S. hortensis*), the Whitethroat (*S. cinerea*), the Nightingale (*Daulias luscinia*), may all be put down as Warblers:

they are very closely related, though not included in the same genus. All of them have a very distinctive song, and none of them, unless we except the blackcap and the whitethroat, have anything at all striking about their plumage.

With the song of the marsh-warbler and reed-warbler, which, as their names suggest, have very similar haunts and are often found together, I am unfortunately not familiar. But they are said to be easily distinguishable. That is certainly the case with the songs of the blackcap and garden-warbler whatever may have been said and written to the contrary. Generally speaking the Warblers may be described as a plainly coloured set, which, but for their song, would be very easily confused. It must be owned that there are exceptions: the Barred-warbler, whose plumage is unmistakable, is said to sing nearly as finely as the Garden-warbler. The Bluethroat (*Cyanecula suecica*), whose skin could easily be picked out from thousands of skins of small birds flung into a chaotic heap, so unapproached is the character of its plumage, has a very rich song, rivalling, it is said, even that of the nightingale. However, there are two forms of Bluethroat, the one with a white, the other with a red spot in the middle of the blue, and this colour distinction may serve to keep apart two forms whose notes are nearly or exactly alike. And seeing that the Warblers, if we count among them a number of closely allied birds that are not actually put in the same genus, are so many more than I have mentioned, it is not wonderful that recognition marks, appealing to the eye, have in some cases been developed in addition to characteristic notes. The two methods of distinction are not antagonistic though they are often alternative. Among the pipits, again, we have several nearly resembling each other in plumage, but whose notes are quite unlike. Such are the tree, rock, and meadow pipits. (*Anthus trivialis, obscurus and pratensis*). The same thing holds true, to a great extent, of the larks. Passing now to the converse proposition we find a number of common tits, the great, blue, marsh, coal, crested, long-tailed (*Parus major, cæruleus, palustris, ater, cristatus* and *Acredula caudata*), very distinct in their plumage, but so difficult to discriminate by their songs that

a knowledge of their various notes (and each has several) requires much time and patience, and may, even given leisure and patience, end in failure. When I have explained my views on the alternative nature of call-notes and distinctive plumage to ornithologists, they have, as a rule, been of opinion that the case for it is not very strong, one (a very advanced student of birds' song) maintaining that all the notes of all the Tits are easily distinguishable to him and, therefore, that each species can have no difficulty in knowing its own from the rest. I cannot help doubting the inference, especially as many birds (belonging most of them, it is true, to more stupid families) are taken in by crude imitations of their own notes. Among birds with decidedly marked plumage and not very great song power may be mentioned some of the Wheatears (*Saxicola*), the Wagtails (*Motacilla*), the Shrikes (*Lanius*), Bullfinches (*Pyrrhula*) (until taught a Bullfinch is no songster). Surely their distinctive plumage has its use. It is sometimes argued that members of a species know each other by "instinct," *i.e.*, I suppose by the aid of some sense which we do not share with them. But when the two senses of sight and hearing are there, highly developed and available for recognition, it is superfluous to imagine another sense existing for the purpose.

Vocal power and migration

I wish now to point out the connection between vocal power and migration. In many species (the cranes, for instance) the loud ringing cries are useful for keeping the trailing flock together. But small birds seem to migrate in silence and the great displays of voice do not take place till their summer home is reached. Herr Gäthe told me that he had never heard the song of the nightingale, and yet during the spring migration the nightingale is common enough in Heligoland. During the winter allied species often live together, willow-wrens with chiffchaffs, meadow-pipits with rock-pipits and very possibly with Tree-pipits. In Egypt, in January, I only once heard the note of the chiffchaff; in Algeria, near Constantine, in the same month, the air rang with their cries. But whether they are dumb or not in winter, when spring comes, a separation must be made and this separation must be possible in many cases, I

believe, only through the possession of a distinctive call-note. The cock-birds, who arrive first, must have some means of attracting the hen-birds when they follow, and supposing that the species frequents woods and not, like swallows, the bright seas of air, success is easiest if they set to and sing their very loudest.

If we investigate, we shall find that among European birds all the great singers belong to species that are migratory over most of their range though our comparatively warm winters make them permanent residents in England. Even *our* nightingales, garden-warblers, willow-wrens, chiffchaffs, cuckoos always migrate, our blackcaps nearly always. Many robins, blackbirds, thrushes, wrens remain with us throughout the winter, yet we must rank them among species that are partially migratory. Their Scandinavian kin, to a bird, move southward in autumn.

Thus there seems to be a connection between migratory habits and power of song, at any rate in cases where the bird is small and of a retiring habit. Obviously the greater the likelihood of the units of a species becoming scattered, the greater the need of some means of bringing them together.

I have been speaking of song as a call-note. It is, of course, a secondary male characteristic and it is used to attract and charm the hen. But song, though a special privilege of the male and though it plays an important part in sexual selection, is, nevertheless, the most powerful call-note of the species, the shibboleth that marks them off from their nearest of kin. Without such a shibboleth how could the chiffchaffs and willow-wrens after spending the winter together, when spring comes, pair according to species?

II

ISOLATION OF SPECIES OF FLOWERING PLANTS

Except when autumn drapes the woods in red and gold, nearly all the variety of colour that plants can boast is due to their flowers. There is no limit to richness of the hue.

Witness the Swiss mountain gentians whose colour far outdoes the blue of the sky, and on the blue, as if that were not beauty enough for one flower, floats a rich purple bloom. But the English flowers, taking the primrose,[1] the wild rose,[2] the grass vetch[3] as examples, are not far behind the Swiss gentians, each in its own kind of beauty. The varieties of shape are no less wonderful than the colours. Take for example the common broom,[4] the dandelion,[5] the purple loosestrife.[6] And these and like things of beauty are to be found over the greater part of the land surface of the globe. The little purple saxifrage[7] is common in Arctic regions where it does much to support animal life. Even in the Sahara there are flowers, though not equal in beauty to those of the more hospitable regions of the earth. Wherever life is thoroughly vigorous, there you find flowers in abundance. If there is any truth in Darwinism it can offer an explanation of this. If it can offer none, it is indeed the barren formula that the Duke of Argyll maintained that it was. It must be a principle of universal application in the animal and vegetable kingdoms or it must fall to the ground. There may be other laws which resist its operation but it must be at work everywhere, or else we must send it to the limbo of exploded theories.

Darwinism must somehow account for flowers

If physical science were to tell us that the conservation of energy is the rule, *except in certain cases*, we should have but little respect for physical science and its laws. In the same way the struggle for existence must go on wherever plants or animals are to be found; Natural Selection must regulate all evolution or else be condemned as mere foolishness.

In spite of this we must expect to find some points of which we can as yet give no explanation beyond such suggestions as the following: the structures that are apparently useless may be correlated with others that are useful: colours may be mere by-products. The latter explanation may serve to account for the lovely hues of the stamens of many grasses, whose wind-fertilised

[1] Primula veris. [2] Rosa arvensis and R. canina. [3] Lathyrus nissolia
[4] Cytisus scoparius. [5] Taraxacum dens leonis. [6] Lythrum salicaria.
[7] Saxifraga oppositifolia.

flowers have no need to advertise themselves and bid for the favours of insects. Lilac-colourèd stamens hang about the spike, beautiful but asking for no reward, like chivalry, the "unbought grace of life." One common wind-fertilised flower, the pink cone of the larch, is certainly conspicuous enough to attract attention and it is difficult to see of what use the colour of these "rosy plumelets" is to the tree. It may be that it is a mere by-product of physiological activities, of the ordinary life processes going on within the plant. It must be borne in mind that the hues of flowers are due to the accumulation and concentration at certain points of material that the plant possessed in small amount before it put forth blossoms, but which, till that time, was not turned to account. The splendid tints of autumn leaves are due to the processes of life within the trees and as far as we can tell are of no use whatever to the organisms that produce them. Let us to this extent grant that things useless exist in the plant world: there is often material which we count as a by-product since it has not as yet been utilised. To make such a concession is not to give Darwinism away. But were we to own that flowers, with all their colour patterns and their elaborate forms, admitted of no Darwinian explanation, then indeed we should have given up so much that it would be well to surrender at discretion. Flowers are no chance by-products nor can any Lamarckian explanation account for them. It is necessary to defend Natural Selection stoutly at this point, since attempts have recently been made to show that flowers are inexplicable on Darwinian principles.

Flowers and inse

I believe it can be shown that all the colours, shapes, and scents of flowers are due to insects and their fellow-labourers, such as humming birds. Darwin held this view. And the facts on which he based his theory are these. Nearly all flowering plants require occasional cross-fertilisation: their vigour diminishes if they are not occasionally fertilised with pollen from other flowers of the same species. So vital is this to their continued existence that many of them have become diœcious, *i.e.*, the male and female flowers are on different plants. In the case of others, *e.g.*, the orchids, self-fertilisation is impossible,

though the same blossom bears both pistil and anthers. Since cross-fertilisation is of advantage to them, it is likely that they would develop some means of attracting insects as carriers. The honey at once suggests itself as intended for this purpose. It may appear sometimes as a waste product on the leaves of various trees, where it is probably of no use to the plant. Its very general presence in flowers must almost certainly serve some useful purpose. That it is useful to the bee we know. But generosity is not the rule among species whether vegetable or animal, and we must, therefore, hold that the systematic production of honey in large amounts brings some advantage to the flower. The brilliant blossoms must surely act in the same way as the honey. They must help to attract insects, which, while occupied about their own business, are at the same time doing the work of cross-fertilisation. If flowers are really useful in this way, bees and other insect fertilisers must have some colour sense, otherwise we should not see the blues, reds, purples, yellows and whites of flowers standing out against the green foliage. And if insects have a well-developed colour sense, then flowers are most splendidly contrived advertisements or sign-boards. They are far more beautiful than any advertisement devised by man; but to the insect for whom they were intended, I believe we may say that they are simply conspicuous. The whole of his small mind is intent upon his work, and there is no beauty unless there is an eye to see it and appreciate it. It is enough for an insect to see and recognise his flower.

Reciprocity

The shapes of flowers show wonderful adaptations to the needs of insects and other welcome visitors. The tube of the blossom of some tropical plants follows the curve of the beak of the particular humming bird for whom they cater—probably he extracts, not the honey, but the insects that are eating it. In many of our common flowers there are converging lines which seem well adapted to direct the bee to the nectary where the honey is found. The flower of the common broom offers a fine platform for the bee to alight upon, and the blossom does not open till the insect comes and applies his weight. The many hanging bell-flowers seem designed to keep out small unwelcome

creatures that would stay and gorge in them, without any service done in return, while they are fairly easy of access to bees. Nevertheless these contrivances do not all work perfectly, and bees will often bite through the top of the corolla of the Comfrey (*Symphytum officinale*), of the common red heath (*Erica cinerea*), of the pink crossleaved heath (*E. tetralix*), thus making a short cut to the honey without putting any pollen on the pistils. Some, however, enter at the mouth of the bell, and do the required work. When she visits Columbines (genus *Aquilegia*), at least those of the cultivated varieties, the bee always, as far as I have observed, bites and takes without giving a *quid pro quo:* no fertilisation takes place. In some columbines so long a spur has been developed that the bee cannot rest upon it, and so leaves it alone as being inaccessible. With wild flowers there is reciprocity between insect and plant, with occasional larceny on the part of the insect.

In order to show that bees are attracted by bright colours Sir John Lubbock made an experiment which will convince most of those who are as yet unconvinced. He took a hive bee to his room and accustomed it to find honey in a certain place. He then let it go. During its absence he put two drops of honey on microscope slides each at a distance of one foot from the spot where the honey originally was and in opposite directions from it; by one drop was placed a flower-head of *Eryngium amethystinum*, which is not conspicuous; by the other were the blue bracts of the same flower which were no less than four inches across. The bee returned ninety-three times, sixty times to the honey near the bracts, thirty-three times to that near the obscure flower-head. In order to make the experiment more conclusive the bracts and the flower-head were transposed after each visit paid by the bee.[1] Colour sense

Sir John Lubbock rightly characterises some experiments made by Professor Plateau as worth little. Professor Plateau covered the petals of some single dahlias (which for us and, very possibly, for bees have no scent) with paper disks of various colours. The bees came as before. Naturally; for when a bee has found

[1] See Journal of the Linnæan Society, April 1, 1898.

honey, she returns from the hive to the same place for more. If it has been moved or covered up, she looks about for it and generally finds it. When he removed the corollas of the evening primrose, the bees explored the whole plant and got honey from the mutilated flowers. They already knew that honey was to be got there and searched till they found it. They inspected the fallen petals but did not attempt to get honey from them. Thus they showed at once their colour sense and their wisdom.

The constancy of bees

Thus far we have shown that plants require cross-fertilisation, and that bees, attracted by colour, effect this for them. That bees may also be attracted by scent hardly requires proof, beyond what anyone may obtain by his own observation. The lime Tilia has very obscure flowers, but the whole tree may be heard buzzing with bees. But now another point calls for investigation.

Ever since the days of Aristotle the bee has had a reputation for constancy. She does not fly from dandelion (*Taraxacum*) to narcissus, but during one journey is faithful to the dandelion, or whatever type of flower she has chosen. By this constancy she gains a great deal. By continued practice at the same exercise she acquires dexterity of limb and proboscis and dives into the nectary and extracts the honey with far greater speed than if she wandered to flowers of a different build. There is but little of the tentative buzzing and reconnoitring that is unavoidable when she is investigating an unfamiliar blossom. At the same time she benefits the flowers far more than she would if she adopted a random method; she very frequently effects cross-fertilisation between flowers of the same species, and that from the plant's point of view is her sole *raison d'être*. But this constancy has its limits and is a very poor foundation for the elaborate theories that have been built upon it.

One of the great difficulties in the way of the origin of species through the struggle for existence and Natural Selection is that new varieties as they arise will be swamped by inter-crossing with other varieties or with the species from which they have diverged. In the case of the bee, then, what we want to know is whether she distinguishes varieties or nearly allied species

from one another. As she works in the hayfields she never confuses orchises with buttercups (*Ranunculus*), thus showing an interesting and valuable power of discrimination. Nevertheless, she is all the while recklessly intercrossing varieties, and species so that if in past times her activity had worked unchecked, it would never have produced any rich diversity of colour in the plant world, but would have left a lack-lustre herd of petty blossoms which would have done nothing to relieve the dull monotony of the green luxuriance about them. But plants are not of a dull monotonous green and there must, therefore, have been some other principle at work, putting a barrier between variety and variety, species and species as new forms arose. This it is, and not her qualified constancy, which has effected the isolation which is the necessary condition, if noble flowers are to result from her work. For insects, unrestricted, would have been authors of confusion and chaos.

A few examples of the working of insects will show their defects as makers of species. In a field of buttercups there are often two species in blossom side by side, *Ranunculus bulbosus* and *R. acris*. The former begins to blossom a good deal earlier than the latter, but the flowering times of the two overlap. If you watch a bee among them she will often for a time keep to one species. *R. acris* stands up a great deal higher, and, owing to this, she will often for a time pass over *R. bulbosus*. But before long she will often change her level and busy herself with the lower-growing species. In a bed of mixed polyanthus flowers bees may be seen going from one colour to another heedless of theories and of the claims of polytypic evolution. The same thing takes place when they are busy upon rhododendrons and columbines of slightly, or even widely, different tints. These instances of infidelity to colour and species I select because I have recently observed them. They are only what might be expected when it is borne in mind that the constancy of the bee is due to her instinctive eagerness to load up with honey with all possible speed, return and unload, then load up again without waste of a moment. She understands her own business, but she cannot be regarded as a good isolator. On the

contrary, her method of working is well calculated to swamp each new variety before it is worthy to rank as a species.

Inter-sterility between species

But this result does not follow since the most closely allied species among wild plants and even varieties within species are sterile *inter se*. Romanes was the first to realise the importance of intersterility. On it he based his theory of Physiological Selection, which I have already discussed. It is impossible to hold with him that a variation in the reproductive cells will give rise to new species if unaccompanied by some other variation that gives the plant an advantage. All I contend for is that favourable variations in flowers have been preserved from the swamping effects of intercrossing by the sterility of the deviating plants when crossed with those of allied varieties and species. That such sterility has played an important part in the evolution of plants can hardly be doubted. A number of French botanists made experiments on this subject, continued through many years, with the object of proving that evolution was a myth.[1] But by the irony of fate the results of their experiments came in opportunely to support Darwinism. These botanists crossed a number of varieties distinguishable only by the most minute differences, and found that the transferred pollen had no fertilising effect.

The bees themselves are always making experiments of the same kind on varieties and closely related species, and in spite of them even many varieties keep true. We are not, therefore, dependent for our facts on the *savants* in question. There is other first rate evidence that any man can verify for himself.

Varieties of garden flowers

This being the case, it is curious that varieties of garden flowers are not characterised by the same intersterility, and require careful isolation, if seedlings are to be like the parent plant. The explanation of this, probably, is that among wild flowers, of all the countless varieties that have arisen, only those have survived in which the advantageous peculiarities have been accompanied by intersterility with nearly allied varieties.

Among wild animals it is probable, as I have said, that intersterility between species is not so general as it is among wild

[1] An account of these experiments is given by Romanes in his *Darwin and after Darwin*, vol. iii. pp. 86-89.

plants. The higher animals at any rate, are capable of exercising choice, and when differences of colour, for instance, show themselves all those of one tint will sometimes shun those of another. This has been the case with the cattle that have run wild in the Falkland Islands. They have separated into herds of different colours, which do not intermix. Yet who can doubt that if members of the different herds were domesticated they would prove fertile together? Among animals, then, it is probable that varieties that were not isolated by intersterility have maintained themselves and gained the rank of species. Among plants there is no such predeliction, and, among them therefore, it is *more probable that intersterility has come into play.*

Varying individuals

To this view it has been objected that there must be varying individuals before definite varieties are formed, and that we can hardly assume intersterility between such individuals and other members of the species. Let us grant this for the sake of argument. We have then only to assume that there was at the outset some geographical isolation. A seed was carried, say, to the other side of a broad estuary, or across a watershed, and so the new variety had time to take definite form before insects appeared bearing pollen from its kin of the main stock. When once intersterility had been established, then geographical isolation might cease without producing confusion. But it is quite possible that sterility with the parent species may often have arisen simultaneously with the favourable variation that characterised the new variety.

Insect workers under these conditions

If it be granted that such intersterility has not uncommonly protected new variations, then it can no longer be denied that the conditions have been favourable for the work of insects. Given isolation, thus assured, it has been possible for them, by perpetually rewarding brilliancy, gradually to make the earth gay with flowers. Each variation in the direction of increased brightness or better adaptation in shape to insect wants was, and is, likely to survive, from the fact of its bringing with it a better chance of cross-fertilisation. The danger of the swamping of new forms through the wandering of bees from one variety to another has been obviated by the intersterility which so generally

obtains. And thus insects have been gardeners with an isolated garden for each species of flower, gardeners for whom new varieties as they arose proceeded to isolate themselves.

Sterility and infertility I have as yet spoken only of complete intersterility between species and varieties. But probably this is too strong a term to use in many cases. When some plants are beginning to deviate from the type to which the rest of the species conform, it may well be that comparative infertility exists between them and their kin, rather than complete sterility. It is well known that when two pollens are put upon the same flower, though both may be capable of fertilising it, yet when they have to compete, one is prepotent. When the transferred pollen comes from another flower of the same variety, it is believed to be prepotent over the home-grown pollen. But when it has developed on a flower of a different variety, it is likely to have less impregnating power than that with which it has to compete. When we are dealing, not with incipient varieties but, with species, absolute sterility is the rule.

In order to perpetuate a new variety that has developed some helpful characteristic when the deviation from the type first appears, it is enough if it be comparatively infertile with its allies. For flowers that are fertilised with pollen from the same stock will produce more seed and the variety will not disappear.

Wind- and self-fertilised flowers Professor Henslow has maintained that insect fertilisation is of no advantage to a plant, since those that are usually self-fertilised get on equally well, in many cases producing an enormous amount of seed, and occupying more of the earth's surface than flowers with elaborate contrivances to secure cross-fertilisation. Some sedges (genus *Carex*) are very widely disseminated, and some obscure compositæ such as the common cudweed (*Gnaphalium uliginosum*).

These are facts which it is impossible to dispute, but the inference from them is unsound. If some species of orchids are comparatively scarce, it is not because they depend on insect fertilisation. On the contrary, it is probable that insect fertilisation has saved a comparatively feeble race from extinction. In such cases, as I have said already, we must con-

sider the whole stock-in-trade, so to speak, of a species, not one particular article. Take an illustration from the animal world. The Grasshopper-warbler (*Locustella nævia*) hides her nest with great skill. She sits close, so that it is difficult to flush her. The thrush (*Turdus musicus*), on the other hand, scarcely aims at concealment: few nests are easier to find than hers. And yet thrushes are far more numerous than grasshopper warblers. This is only one instance among thousands to show that if we wish to understand how different species hold their own, it is no use singling out one characteristic of each, and comparing them in respect of that alone. We must try to learn all their characteristics, their whole life-histories, and the conditions under which they live. This is, of course, only a counsel of perfection, but if we make it our aim, we shall not fall into the error of judging by one peculiarity alone. In the present case we can fall back upon the fact, proved by experiments, that cross-fertilisation does increase the vigour of plants.

It has now been shown that flowers require cross-fertilisation Summary if the stock is to maintain its vigour, and that crossing is carried on in very many cases through the agency of insects; that inter-sterility or comparative infertility between varieties has isolated them so that the defective constancy of bees has not led to the swamping of varieties before they were worthy to rank as species; that bees have a colour-sense, and that owing to this they have fostered and accumulated variations in the direction of increased brilliancy. Insects have been the gardeners that have covered the earth with bright flowers. But they could not have brought about this result, had not many new varieties become at an early stage infertile with each other and with the parent species. We have to thank the colour-sense of bees and the infertility between varieties and between closely related species, working together, for all the colours, forms and scents of flowers.

PART II

PROBLEMS OF HUMAN EVOLUTION

Chapter VII

I

INTRODUCTORY

THE main principles of evolution must, if they are true, be of universal application: what is true of the organic world generally must, if we allow for modifying conditions, be true of man. If development proceeds on Neo-Darwinian and not on Lamarckian principles in the animal and plant worlds as a whole, this must hold true also of human evolution. A strong race must result from a struggle with hard conditions, not from high feeding or other things favourable to the individual. If among wild animals what has been gained by the long-continued working of Natural Selection is lost comparatively quickly when selection ceases, we must expect to find, among men no less, under like circumstances a like degeneration.[1] Adaptation is the rule in the human race as everywhere else in the organic world, and if the conditions of life become soft, then the race will in time become soft and enervated.

Main prir ciples the same

Everywhere in animated nature the same moulding principles are at work. But the circumstances under which men, especially civilised men, live, are exceptional and peculiar. And thus, though the general principles of evolution hold true here as elsewhere, we must study the altered circumstances before we attempt to apply them. As we proceed in the study of human evolution, we shall see the familiar phenomenon, the species adapting itself to its conditions. But we shall see also phenomena that are entirely new to the evolutionist who has limited his attention to the lower animals or to plants.

[1] On pammixis, see pp. 94-103.

Man to a great extent makes his own environment

To begin with, man himself to a great extent makes the conditions under which he lives. When he learnt how to kindle fire and how to use it for cooking, the capacity for digesting raw vegetables and fruits was no longer a necessity for him. When he learnt to fashion tools, the further evolution of the hand became unimportant. The Aye-Aye (*Chiromys*) must have a specially adapted finger for extracting insects from their hiding-places, but man could easily invent an artificial contrivance for this purpose. The use of clothes made climate comparatively a matter of indifference to him. He could migrate from a hot climate to a cold one and could change his mode of life to suit his new habitat. His naked progenitors, if they migrated to a new clime, had, by the help of the elimination of the unfit, gradually to form a race suited to their changed circumstances. Clothes, fire, tools, intelligence and the power of making new discoveries, in course of time made the human race largely independent of this slow and costly process. The history of man has been the history of his subjugation of nature, of his modification of conditions to suit his own needs, quite as much as, or even more than, of his adaptation to changed circumstances. In particular he has striven, and with much success, to mitigate the incidence of Natural Selection. This is certainly true of the human race generally, though some nations, thinking it not stringent enough, have supplemented it by artificial selection: in this connection everyone will recall the Spartans and Mt. Taygetus. But such things belong to a half barbarous stage of development. Civilised man has put such methods away from him as proper only to unhumanised nature.

Mitigation of crises

As I have shown, nature works by a succession of crises. At ordinary times there is for a wild animal no struggle for existence. He lives in peace and plenty and is full of superabundant energy. There comes a crisis, a dearth of his particular food, or a hard season, or one of his persecutors discovers him. Now, it is the object of civilisation to prevent such crises. When the harvest fails in a particular country, corn is brought from distant lands. If frost is severe, we pile on clothes and coal. When disease attacks, we call in the doctor and lie up during the time of

weakness. The policeman protects us from persecution. But the methods of civilisation break down at many points, and, in spite of it, there are many crises still, though their severity is much reduced. By means of a greatcoat we soften the environment in cold weather. But this softer environment cannot be always with us, and the full rigour of our fitful climate may occasionally find the most careful man unshielded. Or, again, a new disease may appear on the scene and nonplus the doctors.

The very fact that sickness can frequently be cured or prevented from being fatal allows the continuance of habits that eventually eliminate a great many persons. Alcohol is said to be responsible for one death in every ten in England, and probably this is under rather than over the mark. Whatever the exact figure, drunkenness is a great means of elimination introduced by civilisation. Among the lower animals such a vice would be impossible, among other reasons, because the drunkards, exposed to cold and to the attacks of enemies, would soon disappear from the earth. *And thus there would soon cease to be any individuals with a tendency to drunkenness.* Civilisation prevents the elimination of drunkards from being wholesale and complete, and thus alcoholism is always with us, clogged and half disarmed, but still alive and venomous. Natural Selection is at work even in the most civilised communities, but the individual is much shielded from its direct incidence. Though not unscathed, he often escapes the ultimate penalty; the tribe or nation suffers for the faults of the individual offender. Natural Selection retreats some little distance, and the ground vacated is occupied by a force unknown lower down in the animal world. Morality and religion—appealing to high ideals which become part of the environment that determines the course of evolution—step in to save the community. They point out to the individual that, though he may for a time be saved from the ultimate penalty due to intemperance, yet the path of virtue is the only one to follow. They exhort him to feed his children, when, thinking only of his own comfort, he might be inclined to starve them. Whenever it happens that the interest of the individual—or what the

Morality and religion: their part in evolution

individual may imagine to be his interest—clashes with the interest of the tribe or nation, then morality and religion intervene to put down the irregular tendency which the slackening of Natural Selection would allow to follow its course, to follow its course for a time, that is. Natural Selection can never be got rid of, though it may be put at a distance. Deviations from right conduct bring ruin in very many cases to the aberrant individual; he loses health or, the society in which his lot is cast being utterly uncongenial, he is somehow eliminated. In any case a tribe or nation whose members are deficient in the virtues that are required for social life is likely to disappear, suffering defeat at the hands of its enemies.

Man by modifying his environment determines the course of evolution

Though man cannot get rid of Natural Selection yet he has a power infinitely beyond that possessed by any other species of modifying his environment, and so determining the course of evolution. Even birds make a sheltered environment for their young, and when they are about to go out into the world show them the path of life they are to follow. The Razorbill (*Alca torda*) coaxes her child to plunge from the cliff into the sea far below, and when he has made the plunge, teaches him how to dive after fish. The duck takes her ducklings to the water and instructs them in the art of foraging. Thus the young of each generation have their environment and mode of life chosen for them by their parents or in some cases by the community to which they belong. And they have to prove themselves adapted to conditions that are not of their own choosing. Human civilisation is an environment which preceding generations have created, and which each generation in its turn, at least among progressive peoples, still further elaborates. Persons to whom such an environment is unsuited are likely to be eliminated: there are many ways in which this comes about. And thus, though there is no inheritance of acquired characteristics, yet a nation can, to a considerable extent, guide the future course of its evolution. Each generation in its turn has power to modify the conditions of life. This is notably the case in the field of morality, using the term in its broadest sense. Each generation can improve the moral atmosphere in which the nation lives.

And if, as the decades and the centuries pass, the process is continued, the race will step by step adapt itself, through the constant elimination of the unfit, to conditions which result from human effort. Thus, as far as morality is concerned, the human race is master of its own future.

Intellect

It does not seem likely that there will be a corresponding evolution of intellect. There is very little elimination for stupidity. A comparatively small number of thinkers, discoverers, inventors do the high intellectual work for the masses of men, who are able to make use of the work done by brains of a higher order, whereas a man's virtue must be his own.

Physique and morality as civilisation advances

Physically speaking, the race continues its evolution, adapting itself to the new conditions which advancing civilisation makes for it. But here the result is not what we should wish. The conditions are progressively softened, and adaptation must therefore mean a decline in physique. Thus intellectually man is hardly able to raise the survival standard: physically he is constantly lowering it. Morally he is able to raise it, and certainly in some nations the upward movement is beyond dispute. And as inventors increase men's wealth and leisure more and more, there must be a corresponding development of moral principle, or the nation will be wrecked for want of it. The bare minimum of religion and morality necessary was very small when almost the whole energy of man was required for the struggle to maintain life. The individual has ample opportunity now to deviate into habits that must be injurious to the nation to which he belongs. Thus the growth of wealth raises the minimum standard of virtue. The nation must grow morally better as it grows richer, or it will be conquered by some other nation that has not lost its equilibrium.

Progress and evolution

What has been said has already brought out a distinction that must never be lost sight of. Progress in civilisation is not the same thing as evolution. But moral evolution, as I have shown, must follow in the wake of progress. When the standard of morality is raised, it comes about continually that those to whom the new atmosphere is uncongenial suffer elimination. Intellectually, there is progress through the accumulation of know-

ledge; but here it would seem that there is no corresponding evolution. How civilisation affects physical evolution there is no need to explain again.

Social strata and evolution

It remains to point out another marked difference in the working of evolution in a civilised nation and in a species of wild animals. Among the latter all the individuals lead the same kind of life—all are subject, speaking generally, to similar conditions. But a nation is divided into classes. The poorest obtain necessary food and clothing only by hard bodily labour—I am speaking now of northern nations. Above the lowest social stratum come, in succession, strata, in each of which there is more wealth and more comfort than in that which underlies it. And since the higher classes are less productive, and do not maintain their numbers, there is a perpetual moving of individuals to the stratum next above that in which they were born, and, only to a much less extent, a corresponding movement downwards. Those who ascend to a higher social level have strength sufficient to cope with the harder conditions that obtain among the class from which they have sprung. Consequently, when they find themselves in an easier environment, they have not only the bare minimum of vigour required, but a superabundance of it. Thus the lower strata of society are a recruiting ground for the upper, which annex the very pick of the hardier stock, and so are continually renewing their strength. Were it not for this, there would be great enfeeblement and loss of energy through the survival amid comfortable surroundings of the weak and unenergetic.

Vigour in individuals may be due to the progress of wealth and science

But, in addition to the strength due to the influx of stronger blood from below, there is invigoration of a sort traceable to another cause. When medical and sanitary science make very rapid progress, so that men understand the laws of health better than their fathers and grandfathers and live under healthier conditions, then a great apparent gain in strength may result. There is, in fact, a race between the softening of the conditions of life (through the progress of science and the increase of wealth) and the physical deterioration that follows in their train. When science and wealth make great and rapid strides, then there is likely to be a feeling that the race is growing stronger. And

this, no doubt, is true if we add the words *relatively to conditions*. I believe that this has happened during the last thirty or forty years to a very remarkable extent. Men born able to live and be fairly vigorous under the comparatively hard conditions that obtained forty years ago, have found themselves living in an easier environment, and are in consequence surpassing their fathers in energy and longevity. Towns have become cleaner: good water is almost everywhere obtainable; epidemics are nipped in the bud; more frequent change of air has lightened the strain of life: there has been less excess and more study of the laws of health. Dr Johnson is said to have made his nights miserable and reduced his vitality by excessive potations of tea. Four bottle men were not uncommon in his time and later. In the present day, without being valetudinarians, men take trouble to discover the diet and the general *régime* which will best fit them for work. Thus, through the advance of science and through the exercise of self-control, they are not only equal to the conditions of life, but have a margin of superiority. But strength due to this cause can only be maintained through a number of generations by a *progressive* softening of the environment, and this must depend upon the continued advance of science and wealth. Should their advance be arrested, race deterioration will then make itself felt.

It may be argued that, even then, things will not have reached by any means a deplorable pass, since no race can be absolutely too weak for its conditions, or Natural Selection will soon set matters right. But a superabundance of vigour is what is wanted, and besides this there is an important point which must not be left out of consideration. The most crucial part of the environment of a species of wild animals is the competing species. Similarly whenever a nation is worth robbing there are other nations waiting to seize its inheritance. In this connection we may well think of the Russians, still living under half barbarous conditions, and still possessed of a barbarous physical strength. Captain Younghusband describes Russian officers as "bursting with health." The Russian peasant, on the other hand, underfed and pinched by cold, does not develop his full strength.

And this failure to attain what should have been attainable draws attention to a distinction to which much importance is to be attached.

Potential and actual strength

Race-vigour is not the same thing as the vigour of the individuals who compose the race. Each human being has at birth a certain amount of potential strength which may or may not be actualised. If the conditions are hard, the weak are eliminated and a strong race results, even though meagre nourishment and hardship allow few or no individuals to realise their rich inheritance. Among the Russian peasantry there is potential strength and to spare. The English race are realising their physiological capital and spending it. By means of good food, warmth, comfort, they are making the most of the existing generation, but at the cost of much race-vigour. This involves a great danger, and as far as I can see there is but one way of meeting it. But the subject is a very difficult one, and I shall put off the discussion of it till a later chapter.

It is clear from what has been said that superabundant vigour in civilised races is gained by a very different system from that which prevails among wild species. Among the latter there are recurrent crises with intervals of ease, peace, and ample food, during which the individual has a large margin of strength. The same system is, of course, in operation to some extent among civilised men, and mainly among the very poor. But it has been greatly modified, and two new factors have become conspicuous, the invigoration of the wealthy classes by the infusion of fresh blood from below, and the progressive softening of the conditions of life.

Chapter VIII

PHYSICAL EVOLUTION

I

EVOLUTION OF RACE-ENERGY

Conflict the source of race energy

ENERGY is born of conflict, conflict with enemies or with stern physical conditions. The savage, armed only with a flint instrument, had enemies fierce and formidable. There were wild beasts who were not far from, or quite, his match. There were other savages ready to fight him for what food or clothing he had managed to get. The barbarian is at a higher stage; he belongs to a tribe with some organisation and with customs that are binding upon all its members. But with barbarians, as with savages, war is the normal state of things; the temple of Janus is closed only during short breathing spaces. The Afridis are now at a stage through which all civilised peoples have passed, and it is said that when an Afridi wants an interval of peace he can only obtain it by enlisting in one of the regiments of the British Raj.

From all this fighting there result great courage and great energy. Conflict with other tribes and wild beasts is the main source to which we must trace the strong combativeness that makes men find a pleasure in overcoming difficulties and facing dangers.

But though there is no practice for fighting equal to fighting itself, yet the tribe which, having for the time reduced its rivals to impotence, settles down, tills the ground, develops the arts of peace and accumulates wealth, has a great advantage in war. Accordingly, some tribes passed out of the stage where hunting and war were the only occupations. They domesticated cattle;

later, again, they took to agriculture. They formed a settled government, became nations, in fact, instead of tribes, and when they had reached this stage fighting came only at intervals—at rather short intervals no doubt at first, but it ceased to be an incessant business—and wild beasts were no longer a perpetual danger. Men now had to be equal to playing two rôles. During peace their occupation was to till the soil or be idle; when war came they had to be good fighters. Now, in some parts of the world the two rôles were far more incongruous than in others. In tropical or sub-tropical countries there was little for the warrior to do during peace. In some lands that are thought highly favoured, you have only to scratch the ground and scatter the seed, and you will have a crop. Not much food is wanted, as you do not have to be constantly keeping up your temperature by using up tissue. You need only a little fuel, just enough for cooking. Clothing is not required except for decency. In some cases patient industry may be wanted for the making of tanks, for raising water from a river for irrigation purposes, or even for ploughing and manuring a small patch when population is crowded. But there is little demand for combative energy. On the other hand, resignation is often much in request; there has to be much patient waiting for the Monsoon or the rising of the Nile. And if the boon prayed for does not come, then the attitude of the Oriental whose favourite word is Kismet seems to be not inappropriate. Patient submission is the virtue of some regions, as rebellious energy is that of others. Rudyard Kipling, penetrating as usual to the "true inwardness" of things, has said of the Indian Ryot:

The warrior in time of peace

> "His life is a long-drawn question
> Between a crop and a crop."

This enables us to understand the enervating effect civilisation very generally has upon barbarians. They occupy, as a rule, the sunnier regions of the earth. Stop their fighting, and you put them in an environment in which sloth is the quality most in demand. The European is indignant that the black man will not work. He himself is energetic, because he has many wants

proper to his northern home and the high civilisation that has grown up there. The black man wants but little, and can't see why he should work hard to supply the wants of the white man.

When civilisation begins to make progress, a difficult problem presents itself, which those who dwell in tropical or sub-tropical climates have failed to solve. This problem is to retain the energy that is born of conflict, when conflict ceases to be an every-day business. Where nature is generous and does not insist that her favours shall be wrung from her, there is not that perpetual weeding out of the unenergetic on which race-vigour depends. Civilisation cannot make progress unless it rests on a basis of physical energy, always ready to combat new difficulties as they arise. In northern lands physical energy has survived, though war comes only at comparatively rare intervals, and then occupies only a small part of the nation. And the explanation of this fact is, I believe, that in the cold north it has required, till recent inventions changed the face of affairs, the hard work of a strong man to get food from the earth for himself and his wife and family. The quality required has been not so much patient endurance, the Kismet attitude of mind when things go contrary, as combativeness, a determination not to succumb to a cruel environment. In northern climates, therefore, energy remained after civilisation had made wars less common. There was still conflict with physical difficulties. And having this basis, life has been in every way keener. Eager competition is the characteristic of the northern civilisation. Nor has it suffered so much as civilised states in the south from despotism. There has generally been energy sufficient in the mass of men to obtain some measure of freedom, though often after long years of submission. And this survival of energy we must attribute to the physical conditions with which the race has to wage perpetual warfare.

Northern Civilisations

This is quite in accord with what I have maintained in the first part of this book, viz., that for any species the most important part of its environment, that which has most to do with guiding the course of its evolution, consists of the other species with which it is brought into contact. Each nation, as each wild

species, has survived or perished according as it has been able or unable to compete with its rivals. For the nation success depended on the possession of certain qualities (physical energy, courage, and loyalty being important among them), and also on the accumulation of wealth, and the advance of science and of law, things which require periods of peace and a settled form of government. Northern nations have been able to pile up wealth by means of the arts of peace, while yet long retaining much of their hardihood. Southern civilisations, on the other hand, have been swept away by barbarous or half barbarous enemies, or if they have survived in places, because sheltered from attack, they show no signs of progress. There is plenty of the Aryan blood in India, but there is very little of what we call Aryan energy. It is to be hoped that the *Pax Britannica* will not kill out the vigour of the Sikh, but it is much to be feared that it will, and that the process has already begun.

Southern civilisations

In the New World there are monuments in plenty of southern civilisations that have passed away. "Great as are the works of prehistoric man in Britannia, Gaul and Mauritania, they are rivalled by those of pre-historic man in the New World. Reference has been already made to the barbaric mound-builders of the Mississippi basin. South of their somewhat formless structures, follow in almost unbroken succession the *casas grandes* of the Pueblo Indians (New Mexico and Arizona): the truncated pyramids and other remains of the Toltecs and their Nahua successors (Anahuac-Tableland); the palace of Mitla (South Mexico), of almost classic beauty; the elaborately ornamented temples, palaces, 'convents,' raised by the Mayas of Palenque, Uxmal, Chichen-Itza, and other cities of Yucatan; the great temples of the sun, the causeways, aqueducts, and terraced slopes of the Peruvian Quichuas. Some of these are pre-historic, while others reach well into the historic period. But none can compare in magnitude and exquisite finish with the stupendous megalithic edifices of doubtful origin, which stand in an almost uninhabitable region near the southern shores of Lake Titicaca on the Bolivian plateau."[1] There was less freedom of inter-

[1] A. H. Keane, *Ethnology*, p. 138.

course among these American peoples than among the young nations of Europe with its many peninsulas jutting out into seas, that served as highways, making war and commerce possible. Consequently they lived amid less invigorating surroundings. It was their ill-fortune too to have no horses to help them in peace and war. And—a far more important point—the climate even on their high tablelands was not hard enough to brace them and keep them vigorous when they lived under settled governments, and their wars came only at intervals. Hence they fell an easy prey to the Spaniards.

In the Old World, Assyrian, Babylonian, and Egyptian civilisations have perished, and the Northern nations alone hold what they have gained, and are advancing to greater triumphs. It may be said, no doubt, that Egyptian civilisation lasted thousands of years, and that we have yet to see whether the peoples of the north will ever look back over a longer record. To argue on such a point is useless, but I may point out that Egypt had shown signs of senility long before Alexander came there to receive her easy submission. Circumstances had brought it about that her rivals were not strong. They had lived under the same enervating conditions as herself, and the results had been the same.

Slavery a cause of degeneration

However, some more northern civilisations also have risen and decayed, and should we be unable to point to any special undermining force, we should be bound to reconsider the question of the decay of southern states. Why did the glory of Greece so suddenly become a mere memory? What was the cause of the palsy with which the Roman empire was stricken? These are very familiar questions, and very various answers have been given. A bimetallist, to explain the decay of the Roman world, tells us that the gold mines in Spain were worked out; hence gold appreciated, and "appreciation of gold always brings ruin with it." This hardly goes to the root of the matter. In a chapter on the *Conditions of Progress* I hope to show that the Romanising of the whole civilised world, and the consequent absence of competition and rivalry, had much to do with it. At present I wish to lay stress upon another factor which I cannot

help regarding as at least one of the most important. Roman society rested on a basis of slavery, and in spite of occasional manumissions we may consider the slave class as a separate caste, between which and even the poorest of free men and women intermarriage did not take place. Now it is well known that the wealthy classes, whether in ancient or modern states, do not succeed in keeping up their numbers; the literature of the Augustan period bears witness to the urgency of the population question. Still more apparent, when an aristocracy form a separate caste, is the failure of energy. The only means of reinvigoration is the influx of new blood from below. But this process is greatly limited by the institution of slavery, under which a very large class is separated off as not belonging to the nation. The course of her history was well calculated to leave Rome more than most states at the mercy of this undermining influence. The long-protracted Punic wars told very heavily on the small farmer class, and the franchise was extended tardily and with reluctance to the Italians. Indeed it was only after wars which still further reduced the small number of her free population, and which left Samnium almost a desert, that Rome consented to give them her citizenship. Thus the evil of slavery as the basis of society was all the more acutely felt.

If we turn our eyes towards Greece we shall see reason to believe that the same cause was in operation there. Nowhere has progress been so short-lived and meteor-like a phenomenon as in Greece; nowhere has the parcelling of the slave-holding nation into minute states aggravated so much the ill-effects of slavery.

Unconsciously modern civilisation has found a means of checking the disease that led to the decline of the classical civilisations. Mr Bagehot maintained stoutly, and gave evidence in proof of his assertion, that the European of our day has become humanised, without losing the toughness of the barbarian. He offered no explanation, but merely adduced direct evidence to establish his contention. It is impossible to doubt that the absence of slavery puts modern civilisation in a stronger position. Freedom of intermarriage among all classes has caused a slowing down of the process of deterioration. The upper classes are perpetually

being reinvigorated by the infusion of fresh blood from below. But the snake has only been scotched, not killed. And though modern communities have greater power of resistance, yet the evil has in the present day greater powers of attack than ever before. Science and wealth advance more rapidly, hastening the softening of the environment and hastening also in the race the process of degeneration which consists in adaptation to soft conditions. By enervating the lower strata of society, they strike the social organism at its very foundation. The nation, like the state of ancient Rome, has not a vigorous substratum of population as its basis.

Effect of civilisatic on the individua.

Here it is necessary to guard against a possible objection. It may be argued that it is not the race which deteriorates, but that luxury has an enervating influence on individuals: they were born strong with plenty of potential energy in them, but it evaporates in the sheltered hothouse life that they lead. Something must be allowed for this, but I cannot help looking upon it as an altogether minor factor. Nothing is more striking than the smallness of the effect upon the individual of the softness and comfort of civilised life. Lucullus, one of the most luxurious representatives of a luxurious age, carries on a series of laborious campaigns with conspicuous vigour. Cæsar, who lived most of the first forty years of his life at Rome and lived like other wealthy Romans, was none the less equal to a succession of campaigns and years of almost unceasing exertion. The same thing is, perhaps, more conspicuous in modern times. There are instances of men who have lived lives of comfort and even luxury and yet are able to go through all the hardships that are inevitable in campaigning and exploring. But, of course, when I speak of comfort and luxury, I mean merely the softness of civilised life, a thing not incompatible with moderation. Long continued habitual excess never fails to incapacitate a man for great exertion.

Some further evidence from history

This resistance of the individual to the weakening effects of luxury compels us to regard its bad effects as indirect. The easy conditions of life enable the weakly to survive. The strong and weak intermarry and the best strains deteriorate through blending

with the worst. Turning now to English history we see some remarkable phenomena which may, I think, be considered to illustrate our present subject. The energy that characterises the British race seems to centre now in one part of our small islands, now in another. In Queen Elizabeth's time, an age of unsurpassed energy, Devonshire produced a number of great men. It is enough to mention the names of Drake, Hawkins, Grenville, Raleigh. Exclude the men of Devonshire and there is left an enormous blank. In the time of the Commonwealth the men of eastern counties fought with indomitable spirit. The long Napoleonic war brought a number of Irish and Scotch names to the front. The energy of the race is found mainly now in the north of England, in Scotland, and in those parts of Ireland where there is a large admixture of English and Scotch blood. There it has been during this century, and if we look through the long lists of our men of action we shall see that Scotland and to a less extent the north of Ireland supply a number out of proportion to their population. On the other hand, if we pass in review the names great in literature, the superiority of the North is not maintained, while Ireland cannot be said to show much strength. In science, if we reckon by numbers of great names, Scotland has still the advantage, I believe, but not so markedly as when we reckon up the men of action. What is the explanation of this phenomenon? I offer one with some confidence, while carefully guarding myself by saying that there may have been other causes working in the same direction. I believe that great physical strength and great energy are characteristics of the population of those parts of the country which, whatever advantage they may gain from a somewhat harder climate, certainly owe more to the fact that civilisation has comparatively recently brought to bear upon them the full force of its weakening influence. The poverty of Scotland has obliged her people to lead a hard life and the result is that her sons have more of the tough physique of an earlier stage of civilisation. Thus in competing with Englishmen in campaigns or in the Indian Civil Service Scotchmen have forged ahead through superiority in physical stamina. At the same time Scotland has always been

ahead of England in another way; education there has not been the monopoly of the wealthy. Thus she has had the good of civilisation without the harm. We, in the south, have felt its deteriorating effects, while we have been slow to disseminate its blessings among the masses.

Looking further afield we see civilisation producing similar results in past times and in our own. The Persians of the mountains come down and conquer the Medes of the plains. One wave of conquest after another sweeps over the plains of India. The hard races from the mountains of the north are more than a match for the dwellers in the soft climate south of the Himalayas. And we ourselves are able to hold India only because we never attempt to settle there as colonists. Should we ever make the experiment, and should the government of the country be entrusted to the sons of the settlers, our Indian empire would soon be a thing of the past. We are able to hold India because we bring to the task the vigour that is bred by a harder climate. And our environment has acted, not so much by bracing the individual as by eliminating the weaklings of the race. Hence the physical strength which is certainly one of the qualities that are essential in an imperial people.

The evidence would lead us to the conclusion that conflict with other races or with hard physical conditions is necessary, *not only for the evolution, but for the maintenance of vigour.*

> Let the luscious south-wind
>   Breathe in lovers' sighs,
> While the lazy gallants
>   Bask in ladies' eyes.
> What does he but soften
>   Heart alike and pen?
> 'Tis the hard grey weather
>   Breeds hard Englishmen.[1]

[1] From Charles Kingsley's *Ode to the North-East Wind.*

II

NATURAL SELECTION AMONG CIVILISED MEN

Natural Selection still at work Natural Selection is still at work, though every effort is made to arrest its operation. As in the animal kingdom generally, it acts mainly upon the young, a fact which comes out very clearly from the study of the mortality tables. In 1897 the mortality of infants under one year in London was 159 per 1000 births. This was only slightly above the average, which for the ten years ending with 1897 was 155·4.[1] Thus the eminent man of science who looked around him and proclaimed that he saw no struggle for existence going on, did not see beneath the surface. Mentioning by name several men of note, he asked: "How can they be said to be struggling for existence?" Quite true, on those who win easily there is little of the dust of conflict to be seen. That goes without saying, and he only stated a truism. It would be easy to point to thousands of men whom it would be ridiculous to describe as struggling for their lives. The struggle for existence extends throughout the organic world, and yet for years a giant of the forest stands unassailed by anything beyond small irritating pests. And so to a less extent in the animal world. The stress comes at certain crises, and though throughout a man's life disease is on the watch for a weakness in his armour, the most important of these crises is the time of infancy. But the chance which an infant has of surviving does not depend entirely on his physical strength. It depends very largely on the wealth and social position of the parents. Among the classes who have ample means and some amount of education, the infant death-rate is far less. If the Registrar-General published reports of the rate among the various social classes, very interesting facts would be brought to light. At Copenhagen, it seems, this has been done. And there we learn the gross fertility is higher in the artisan than in the professional class, but the net fertility

[1] See the *Annual Summary of births and deaths in London* for 1897, page 33.

is lower. The explanation of this, no doubt, is that, among the well-to-do, children are taken greater care of, with the result that the infant death-rate is lower. This is the case in England also. The great infant mortality, especially in our big towns, is due very largely to the ignorance and poverty of the parents, in some cases to their cruelty. Though no exact figures are available, we may feel quite sure that of the children of the well-to-do a far smaller percentage die in their first year, the reason being that they are better cared for. I cannot accept the explanation given by Professor Karl Pearson.[1] "The death-rate," he says, "rises continuously and uniformly with increased fertility." The meaning of which, if I understand it correctly, is that there is more weeding out of the children of large families through physical defects than among those of small. The truth, I believe, is that large families are as a rule found in the poorer classes, and consequently are more likely to suffer from want of care. Even if it should be found that among the more wealthy the infant death-rate is higher in the case of large families, it seems likely that the explanation is not a physiological one, but rather that maternal care, having to distribute itself over a number, is less effectual in warding off the many dangers to which children are exposed.

We see, then, that though the competition under modern civilised conditions is not a life and death struggle—the most unsuccessful need not starve—yet many of the children of those who fail die as infants owing to the ill-success of their parents. This ill-success is very often due to the lack of certain moral qualities which are indispensable in civilised life, and as these moral defects in the parents are in many cases transmitted to their offspring, there is through this high mortality among the children of the very poor a constant elimination of those who are deficient in character—a subject to which I shall have to return.

Estimate of the percentage eliminated

We have now seen how great is the amount of infant mortality. But we are not yet in a position to estimate the stringency of

[1] See Prof. Karl Pearson's paper in *Natural Science*, May 1896.

Natural Selection. In order to gauge it with approximate correctness, we must find out the lowest age at which marriage commonly takes place and the percentage of the population who die before they attain this age. For all those who leave no offspring we may, for our present purpose, look upon as having been eliminated; they are of no account in the physical evolution of the race. Now in 1896, of the bachelors who married in England less than 6 per cent. were under 21. Women marry younger, but of the spinsters who married, less than 19 per cent. were minors. Turning now to the deaths[1] of the same year I find that 47·9 per cent. of the males and 44·5 per cent. of the females were under 21.[2] In the male sex we may hold that quite 47 per cent. die before the marriage age since the number of men who marry under 21 is so small that it is practically a negligible quantity. Of the spinsters who became wives in the same year 18·8 per cent. were minors, a far larger proportion. But if only 18·8 per cent. of the spinster brides are under 21, obviously quite an insignificant percentage of the whole number of females born marry before that age. Moreover, of this insignificant percentage a large proportion live to be much older and consequently are not to be accounted in the number of those who die under 21. Now if we take the year 1896 as typical (as we fairly may) these amount, as I have said, to no less than 44·5 per cent. of the females born. Nearly all this high percentage, therefore, we may reckon among the eliminated.

But it is possible to quote figures that will show the facts in a still more striking light. The mean age at which bachelors married in 1896 was 26·59; in the case of spinsters it was 25·08. For brides and bridegrooms together, therefore, it was 25·83. Now the percentage of the total population who die under 25, if we may judge by the returns for 1896, is 48·2. These figures

[1] See the Registrar General's Report for 1896, p. 118. For ages of marriage see pp. 13, 14.

[2] To find this number has required some calculation as the Registrar General's returns do not give the deaths in each age-year but in each group of five years. To find the number of those who died in their 21st year, I have taken one-fifth of those who died from 20-25. The death-rate at this age is low and the possibility of error is small.

compel us to decide that over 48 per cent. of the population are not to be reckoned in, when we are considering the question of physical evolution. The physical future of the race has nothing to do with them.[1]

Reproductive Selection

But as yet we have not seen by any means the whole extent of the elimination that goes on. There is constantly at work the principle of reproductive selection, as Professor Karl Pearson has called it, and this is, in reality, only a form of Natural Selection.[2] Twenty-five per cent. of the mated population in England and Denmark produce one-half, or slightly over one-half, of the next generation. Here is a very remarkable fact. In estimating its importance we must bear in mind that fertility may be regarded as a proof of good physique. This can hardly be disputed, even if we consider, not the net but, the gross fertility, *i.e.* if we reckon all the children born, and not only those who grow up to continue the race. In many vigorous families there is not much difference between the two—the net and the gross—since of a number of children born most survive till the age of marriage. In fact, through the working of Natural Selection fertility must inevitably come to be correlated with fitness to survive. This being so, reproductive selection must be counted among the causes that go to make the race strong. It is, in fact, a most effective, though less obvious, form of Natural Selection.[3] Families which are highly unprolific are likely to become extinct; the race is kept up by, and gets its character from, the more fertile stocks.

[1] Illegitimate births have to be left out of the calculation as the ages of the parents are not given in the returns. But they numbered in 1896 only 4·2 per cent. of the total of births, and are, therefore, an unimportant factor. See the Registrar General's Return, p. 17.

The ages were unrecorded in less than 2 per cent. of the marriages. In some cases there is, no doubt, an understatement of age. This is shown by the fact that in each successive census the number of women returning themselves as between 20 and 25 is larger than the number of girls returned in the census of ten years earlier as between 10 and 15. See the "Census Report" for 1891, vol iv. p. 28, where it is shown that the error due to this amounts to less than 5 per cent. If we assume the same percentage of mis-statement in the case of brides, it will not materially affect our conclusions.

[2] See *Natural Science*, May 1896.

[3] See p. 240.

Natural Selection among wild animals and among men: a contrast of methods

It is clear now that man with all his science and knowledge of physical laws has not been able to put an end to *Natural Selection*. He has mitigated the struggle for existence, but it *still* goes on. Among men, as in the animal world generally, elimination takes place mainly among the young. *But* the process of elimination among the lower animals is very different from what it is in the human race. Young swallows, for instance, live, while in the nest, in comfort and luxury. Their parents devote their lives to catching flies for them, so that the huge appetites of the young fledglings are at length satisfied. When they leave the nest they are still fed on the wing by their parents. This, however, does not last long. They must catch flies for themselves, and they must find their way, the first broods at anyrate, to Africa unescorted, unguided. And the next year there are no more swallows than before, though there is reason to believe that most of the old birds have once more reached their homes in the North. The young birds, then, after being fed up by their parents to the utmost have been left to face a crisis for themselves. And the result has been that most of them have succumbed. All had their strength developed to the full by high feeding and favourable conditions, then the less fit were eliminated. The inferiority of the system that obtains among men is at once apparent. The feeding and bringing up of the young, among large masses of our population, leave a great deal to be desired. A number of deaths are due to insufficient food, some to actual starvation, many to unsuitability of diet.[1] Thus the struggle for these many thousands is against unsatisfactory conditions during babyhood. Even the survivors never attain their proper strength. Among the lower animals there is proper nursing during the all-important time of helplessness. Then comes a test which weeds out the weaklings. For the child of civilised parents there is often neither such good nursing during infancy nor such a test of stamina afterwards.

Struggle among nations

Side by side with the struggle between the individual and

[1] The Society for the prevention of cruelty to children has brought to light many ugly facts. It deserves the gratitude of all English people for the work it has done.

the physical conditions of life, side by side with the competition between man and man, in which even now the question of life or death is often involved, there is going on a struggle between nations. Even during times of peace there is a race for the most habitable or wealth-producing parts of the earth, and the question who shall occupy them is decided largely by the amount of armed strength that the rival claimants among the nations have to show. In fact it is a state of perpetual war in which the combatants, as a rule, instead of coming to actual blows display their forces, upon which the weaker retires, ruminating on enlarged military or naval programmes. Though it can never happen that any of the European nations, even in the event of a great war, ending in the complete victory of one side, will disappear in the sense that it will have no descendants, yet the number of its descendants depends very largely on wars and menaces of war. The country that secures the best of the earth will send out more colonists than the country that has to send its sons to live among foreigners and speak a strange language.

The mor factor

National prosperity and strength lead to rapid multiplication: and national strength depends as much on moral evolution as on physical and intellectual evolution. The citizens must be ready to make sacrifices for the common good: the rich must see that the poor are lifted out of squalor. Without this, hard conditions may make the breed physically strong, but the nation will be weak. National strength is the resultant of two factors which find it difficult to go in harness together: of a hard environment, that makes the component units of the nation hard as itself, and of a spirit of mutual help that in days of wealth and science tends to soften all that is hard.

Sexual Selection

Sexual Selection works side by side with Natural Selection, supplementing it and making it more drastic. I have written at length on its working among mammals and birds and here it is only necessary very briefly to recall the conclusions arrived at. The result of sexual selection, *e.g.* among migratory birds, is that the best pair with the best and the worst are left to pair with the worst. And thus the hand of Natural Selection falls very heavily

on the offspring of the latter. Where the arbitrament is by battle among the males, the working of sexual selection needs no explaining. Generally it may be said to take the place of the scientific breeder of domestic animals, who not only eliminates the worst but selects the best.

Does sexual selection play the same part in the human race? The most people would say "not," and most decidedly. Questions of money interfere, no doubt. But the fame of heiresses is so great that their number and importance is much exaggerated. Moreover, there is occasionally (very rarely, it must be owned, but such cases do occur) an heiress who, in spite of her large fortune, is left without suitors. And, after all, we are concerned, not with the wealthy classes, but with the great mass who are called the workers. Among them there are no great accumulations of capital, and a capable workman has no need to marry money if he wishes to get on in life. A young workman wishes someone to keep house for him, and he will shrink from marrying a girl who is likely to be too sickly to make his home comfortable. It is clear from the nature of the case that he can never be indifferent to such a question as physical vigour. And there is no need to lay stress upon the abhorrence that is felt for any serious deformity.

The case, no doubt, is far from simple. Certain accomplishments beyond mere health and strength are wanted—such things as sewing, washing, cooking. But the acquirement of such accomplishments requires energy, and energy is largely dependent on health.

It must be owned that it is impossible to produce any statistics bearing on such a question as this, and it is becoming the fashion to accept no proposition that does not admit of statistical proof. For all this there is reason to believe that sexual selection among the poorer classes, and to a less degree among the rich, operates to a considerable extent in the same way as among wild species. It gives emphasis to Natural Selection and makes it more drastic. It tends towards the pairing of the more vigorous with the more vigorous and the inferior with the inferior, thus preparing the ground for the working of Natural Selection.

Elimination: how far selecti[ve]

It only remains very briefly to consider the question what proportion of the total number of deaths is really selective, and what proportion due to accidental causes. Professor Karl Pearson calculates that no less than 80 per cent. of the death-rate is selective. It may be questioned whether the data are available for so exact a calculation. But premature death can in so many cases be traced to some defect, physical or moral, that the estimate can hardly be considered excessive.

Summary

We have seen now that Natural Selection eliminates over 48 per cent. of the population before the age of marriage. And owing to Reproductive Selection, which is a form of Natural Selection, 25 per cent. of the married couples in each generation are the parents of half the next generation. To this we have to add, what I believe is a very large addition, the influence of Sexual Selection. Natural Selection, thus fortified and supplemented, still works among civilised men with an effectiveness which must not be underestimated because it is impossible to express it in figures. Whether its stringency is sufficient to prevent degeneration I shall discuss later on.

Natural Selection deals not only with individuals but with groups: there is a constant struggle among nations, success depending as much on moral as on physical qualities.

III

MITIGATION OF THE STRUGGLE FOR EXISTENCE

General survey

THE struggle for existence must be distinguished from the struggle for success. If only our successful men survived, our population would indeed decline.

It is not difficult to show that the mass of English people live in greater comfort now than they did near the beginning of the century or fifty years ago. After Waterloo there was a time of terrible distress. Bad harvests and heavy taxation made life hard. Mouldy corn was not given to the pigs as it is now, but was made into bread and eaten by human beings. Till the

abolition of the corn laws there were at intervals years of great scarcity, when wheaten bread rose to a price that for the poor was almost prohibitive. The Irish famine brought matters to a crisis. Since then, if we except the year 1855, the old high prices have been unknown. The town folk are on the whole much better off. They have cheap food and a constant supply of clean water. The housing of the poor, if it leaves much to be desired is nevertheless improving. Hospitals put medical skill and appliances at the service of all. The workhouses have shared the upward movement and have been made more comfortable. And it must not be forgotten that most big towns have the great charm that has been claimed for Glasgow: there are remarkable facilities for getting away from them. And of these facilities an ever growing percentage of the inhabitants are able to take advantage. I hardly think they are like the townsman that Mr William Watson writes of, who:

> In stainless daylight saw the pure seas roll,
> Saw mountains pillaring the perfect sky:
> Then journeyed home to carry in his soul
> The torment of the difference till he die.

More often they are freshened up by their holiday, and resolve to have another as soon as possible. In the country villages things have improved, though hardly in an equal degree. Cottages are better built. Wages are higher, while food is cheaper. Doctoring, through the help of clubs, is often to be had for a very small sum, even when the patient will not condescend to receive medical relief. As a set-off against this, it must be mentioned that the percentage of people who live in our big towns is yearly increasing, and to the end of time the country will keep ahead of the towns in healthiness. Not many men are wanted on the farms, since machines do much of the work. Hence the fine Irish-bull made in England: "The human race will be unnecessary soon." But much as we may regret the depletion of the rural districts, we can find consolation in the fact that the superiority of the country to the towns *qua* healthiness has already decreased, and is likely to decrease still further. All the best products of the farms find their way to the great

centres of population, and are to be bought there for a reasonable price. Moreover the great rapidity and cheapness of ocean portage is helping a great deal to improve health in the most squalid and crowded districts: oranges and bananas, being cheap as they are, must be reckoned as an important means of health to the poor. Sugar, partly through the continental bounty system, has become cheap, and forms a most valuable item in the diet of poor children. Much of it is used for jam making, that great and growing industry, on which any one who is interested in the welfare of the people ought to look with favour. To all this we must add that epidemics in the present day are very mild compared with their great predecessors. There are no visitations like the Black Death in the fourteenth century, the Sweating Sickness in the sixteenth, or the Great Plague in 1665.

Improved drainage, vaccination, isolation and other means nip epidemics in the bud, and rob them of half their terrors. There is sometimes an outbreak of smallpox, such as the recent one at Gloucester, which gives rise to much talk and some alarm, but does not spread far. There is, moreover, a spirit of altruism in the present day which leads the rich to help the poor, perhaps more than ever before. Charity, both wise and unwise, is at work in all directions, relieving hunger and distress. When a strike threatens many families with misery, the philanthropic are eager to subscribe for the help of the sufferers. "I have no means of knowing which side is in the right, but I send £15 for the workmen," so wrote a distinguished ecclesiastic during the engineers' strike. "Puzzled but subscribing," to quote Lord Beaconsfield, describes the attitude of the English people on a great many occasions. Thus altruism, wealth, science all combine to make the life of the poor easier. And to this we may add that the State has relieved them of the burden of education.

Amount of alcohol consumed

If I have correctly represented the general tendency, we ought to find evidence of it in the returns of the amount of alcohol consumed annually in the United Kingdom from 1885 to 1897. Drink reflects the prosperity of the people. When wages go up, more is drunk. In 1885 our people drank 27·1 gallons of beer per head annually. In 1897 the amount had

advanced to 31·3. Taking spirits, we find the average annual consumption per head in 1885 was 0·96 of a gallon; in 1897 1·02.[1]

I have not any statistics for years previous to 1885, but the figures at our disposal tell their tale very plainly. They show that during the period in question there has been a marked increase in prosperity. In other words, the environment has become softer. I am quite aware that alcohol itself is an eliminator: it destroys those who indulge in it to excess. For them it hardens the environment and makes it more exacting. But it is only a minority who are thus affected. There is an enormous majority who do not drink to excess, and who are not injuriously affected by the drunkenness of others. In their case we may infer that there is greater comfort — more money to spend and, on the whole, a wise use of it. The increase in the consumption of alcohol is proof that the great mass of the people live in easier circumstances. The housing, clothing, and diet of the poor, there is every reason to believe, have improved *pari passu* with the rise in their drink bill.

Reduction in the death-rate

But the best evidence of the softening of the conditions of life is found in the diminishing death-rate. From Porter's *Progress of the Nation*[2] I quote some figures derived from the London *Bills of Mortality*.

	Percentage of deaths under 20 years of age.
1751-1760	$51\frac{3}{4}$
1761-1770	$50\frac{3}{4}$
1771-1780	$52\frac{1}{4}$
1781-1790	$49\frac{7}{8}$
1791-1800	$49\frac{7}{8}$
1801-1810	$47\frac{7}{8}$
1811-1820	$45\frac{1}{10}$
1821-1830	$46\frac{1}{4}$
1831-1840	$44\frac{1}{10}$

I believe that the figures just quoted may be taken to be

[1] See the report on *Alcoholic Beverages*, published by the Board of Trade, 1897.

[2] P. 23.

fairly correct relatively to one another. But probably as we near the present day, they approximate more and more nearly to accuracy. In spite of this nearer approximation, if I am right in assuming it, there is a marked decrease in the death-rate. When, however, we find that, even in 1896, of every hundred persons who died in England no less than 45⅘ were under twenty years of age, we cannot but suspect that the Bills of Mortality are only roughly correct.

We are not on thoroughly solid ground till we come to the first of the annual reports issued by the Registrar General in 1839. Since then the rate of mortality has declined to a very appreciable extent. It is true that the death-rate among infants under one year of age does not show any marked decline. Indeed, from 1841-50 of every 1000 children born in London 157 on the average died in their first year, and from 1891-97 the average has been 157·85. But when we take the annual mortality of children in the first five years of life, then the decline is unmistakable, and still more so between the ages of six and ten, and eleven and fifteen.

Deaths of males to 1000 *living in England.*

	Years of Age.		
	1–5.	5–10.	10–15.
1841-50	71·2	9·2	5·1
1851-60	72·7	8·5	4·9
1861-70	73·5	8·2	4·5
1871-80	68·5	6·7	3·7
1881-90	61·6	5·4	3·0
1891-95	62·1	4·5	2·5

It is after 1870 that the decline between the ages of one and five first appears. Among female children the tendency is the same and still more decided. But the tide turns after a a certain age, and earlier among men than among women.

Annual death rates to 1000 *persons living in England.*[1]

	Years of Age. 45–55.		Years of Age. 55–65.	
	Males.	Females.	Males.	Females.
1841-50	18·2	16·1	31·8	28·4
1861-70	**19·2**	15·6	**33·1**	27·9
1881-85	**19·3**	15·1	**34·7**	**28·5**
1891-95	**19·8**	**15·3**	**36·1**	**29·8**

These figures show the first upward movement in the death-rate. In both sexes it first appears between the ages of forty-five and fifty-five; but in men it was noticeable at an earlier date, in the decennial period 1861-70 compared with the previous ten years; in women there is no increase till 1891-95 and even then it is far too slight to be conclusive. Between the ages of fifty-five and sixty-five the death-rate is heavier in both sexes than formerly, but not so much heavier by a great deal among women as among men. It must be remembered that these statistics refer to all classes. Insurance societies do not find that the expectation of life after forty-five tends to diminish. In fact the tendency to increased mortality after that age does not extend to what we may call the careful classes. Holders of life annuities live to unconscionable ages. It is possible, too, that though the figures seem to show a definite tendency, it is only a fluctuation. The Reports for 1896, 97, 98 reveal a fall in the death-rates of both sexes at the ages in question.

So far we have found that the death-rate among the young is much lower than formerly and that in spite of the survival of many weakly children there is greater expectation of life than there was, at any rate till the age of forty-five. Obviously the explanation of the increased longevity must be that the conditions of life are softer, not that men are born stronger. Life is becoming easier, especially for young children, but the tendency is by no means equally active everywhere. The variation in infant mortality in different parts of London is extraordinary.

[1] The figures are printed heavy type when there has been a rise in the death-rate.

	Deaths under 1 year to 1000 births registered in 1897.
St George in-the-east	197
St Saviour (S. London)	195
Limehouse (E. London)	193
Hampstead (N. London)	127
Stoke Newington (N. London)	121
Plumstead (S. London)	116[1]

Differe: parts o: Londor

Poverty and a high infant mortality go together though there are other minor factors.

If we compare the big towns with the mainly agricultural counties, the difference is most marked in the death-rate both among infants and among the population generally.

Deaths per 1000 *living in* 1896.

	All ages.	Under 5.
London	18·2	66·5
Lancashire	19·8	66·4
Wiltshire	13·8	29·2
Westmoreland	13·4	28·2

Town a country

Lancashire with its big manufacturing towns beats even the London death-rate for all ages. Not only is the country blessed with easier conditions of life but the rate of living there is slower and as a result there is greater longevity. In particular it must be noticed how badly infants fare amid the squalor and racket of big towns. Contrast the 28·2 of Westmoreland with the 66·5 of London! Yet if we compare London with its past self, there is a great improvement.

Annual London death-rate to 1000 *persons living.*

1851-55	24·8
1871-75	22·9
1893-97	19·16

London a whole

Estimate of the amount of the reduction

The set of the tide must now be clear to anyone who has taken the trouble to read the figures I have quoted. It only remains if possible to find some easily remembered fact

[1] See Annual Summary of Births and Deaths in London 1897.

that sums up all the others. We must take a year some way back, and comparing it with some recent year, see how much smaller a percentage of the persons born are eliminated now than at the earlier date. First, I must recall what has already been said, that when we are considering physical evolution we may reckon all who die unmarried as having been eliminated. Now in 1896 the mean age of marriage was 25·83 (for bachelors 26·59, for spinsters 25·08), and according to the tables for that year 48·2 per cent. of the population die under 25.[1] But some forty years ago, if we judge by the returns for 1859, the percentage was no less than 57·1.[2] If, then, the mean age of marriage was the same then, nearly 9 per cent. more were eliminated then than now. Unfortunately the ages of bride and bridegroom at that date were so often unrecorded, that it is impossible to discover exactly the mean age of marriage. Ever since 1885 (by which date no more than 7·1 omitted to state their ages) there has been a slowly growing tendency to marry later in life. But the figures available do not go to show that the tendency had set in before 1885. Even then it is very slight, though definite—25·38 the mean age in 1885, 25·83 in 1896. In 1859, if we take the 64·6 per cent. who stated their years as representative of all, the mean age was 25·54. No doubt we are making an assumption that may introduce error, but the correction of the error could hardly reduce the figure below 25. We are not, therefore, guilty of over-statement when we say that 8 per cent. less of the population are eliminated now than forty years ago.

It is clear that the change is due to the softening of the conditions of life, not to an absolute increase of vigour. The infant mortality has been much reduced, so that many now grow up, who formerly would not have completed their first five years. In spite of the survival of the weakly, the reduction in the average death-rate continues even among those who have passed the age of 40. We have side by side, then, a reduction of strength and an increase of longevity. Men live longer because their environment is less trying.

[1] See the Registrar-General's Report for 1896, p. 118.

[2] Report for 1859, p. 98.

Race vigour vigour in the indivic

Here I may recall what I have said before, that strictly speaking all strength is relative to conditions; hence, if the conditions soften more rapidly than physique deteriorates, the net result is that there is an increased amount of physical strength available in the nation. But in estimating the value of this increase, we must not lose sight of an important distinction: vigour in individuals is not the same thing as race vigour. It may be due to an almost ideally good environment. Race vigour, on the other hand, is the product of hard conditions: when an individual sprung from a race thus evolved is transplanted to a softer environment, then personal vigour is most likely to make its appearance since it consists in an ample margin of superiority to conditions. In places and in social strata in which the death-rate is high we may consider that race vigour is being maintained by the elimination of the weakly; where it is low the strength of the existing generation is being developed and made the most of—a process that is fraught with danger, since it involves the survival of many persons of poor physique, and as a consequence, I believe, unless the process is checked, eventual race-deterioration. It is, in fact, a draught upon capital. That there must be some decline seems to follow as a necessary consequence from the facts. To take an extreme case: suppose that all elimination ceased, and that all of this generation left descendants instead of only the more vigorous 50 or 52 per cent., English physique would clearly drop below its present level. But the question is whether having dropped so far, it would drop any further. Some biologists maintain that the characters a race has once gained belong to it in perpetuity, unless they are removed by Natural Selection. They cannot be lost, it is maintained, merely because they are no longer specially selected; if elimination for a particular defect ceases there will be a decline from the survival mean to the birth mean, but no further. On the other hand, Weismann has contended that there will be a process of retrogression or degeneration which will continue as long as the environment continues to become less and less exacting. This question I am going to discuss in the next chapter.

Chapter IX

THE QUESTION OF PHYSICAL DEGENERATION

INTRODUCTORY

IF it be true, as I have tried to show, that in wild species stability is maintained only by wholesale elimination of those that fall more than a very little below the average, it follows that instability must result from the relaxation of the system now observable among civilised peoples. Among the variations tolerated will be many of a distinctly retrogressive character: there will be loss, partial or complete, of powers and faculties formerly essential, in fact, what is called degeneration.

As to whether degeneration, slow or rapid, is actually taking place, opinions are much divided. The optimists have a good deal of evidence to adduce if it will only stand investigation. There is the increased stature of women in the present day, a very striking phenomenon among the upper classes, not a matter of mere fractions of inches discovered by careful measurements, but visible to anyone who is capable of observing. There is the constant advance in the athletic records. There is the fact that our explorers seem to stand hardships as well as any of their predecessors, while our soldiers go through campaigns side by side with men of less civilised races. The athletic tendency of the present day must, it is maintained, lead to an improvement in physique. Longevity is increasing and, finally, as to diseases, many that are fatal to savages civilised man throws easily off him when they make their attack.

On the other side there is much to be said. No breeder of horses would hope for good results were he to take for the stud

the best and the worst indiscriminately. No practical breeder is so Lamarckian as to suppose that any process of training could do much to mitigate the bad results that would follow from such a system. The question of stature presents a good deal of complication and I say nothing about it at present beyond this, that unjustifiably big conclusions are often built upon the facts observed. As to athletic records, they are due partly to skill, not entirely to physique. And we must bear in mind that there is now a far larger number of young men devoting themselves to athletics. Formerly many who had the greatest capacity remained inglorious and unsung, their powers unknown even to themselves. But if a general advance in physique is expected as the result of athleticism, it must be remembered that a very large proportion of the population is even now untouched by the athletic movement. They bet and cheer, but do not enter the arena themselves, knowing that they could not rise to eminence. And there still remains the question—if it really is a question still—whether any race improvement would result from the improvement of the individual due to better conditions of life. As to our soldiers, the commissariat is much better managed than formerly, and, great as are the hardships they have to undergo, yet compared with what it was, say, ninety years ago, campaigning is luxurious. The same argument holds with regard to explorers. They know how to live in the regions in which they travel, and they take many of the appliances of civilisation with them. They are less cut off than formerly. Moreover, it must be remembered that explorers and to a less extent soldiers are picked men. Those who take an optimistic view say little about such things as teeth and eyesight. It is owned by all but the most irrational optimists that in these respects civilised man has degenerated. With regard to longevity, the figures require careful analysis. The increased average length of life is due mainly to the survival of many infants who can hardly become vigorous men and women, or to the sheltering of persons, who have lost all vigour, from the risks and hardships of active life. In their contention with regard to diseases the optimists have a very strong case.

Civilised man can undoubtedly weather many diseases that are fatal to the savage. But is it certain that this power will remain his, now that medical science is advancing with a rapidity unknown hitherto and shielding him from enemies against which formerly his own strength of constitution was his only defence?

For the Darwinian the matter might seem to be settled by the simple statement that all organisms tend to become adapted to their surroundings. If, however, a race character, once it has been well established, cannot be lost or seriously impaired in less, say, than 100,000 years, the vital question still remains unanswered.

The more important points at issue, I shall, therefore, discuss in some detail, bearing in mind that what we wish to know is not so much whether degeneration is taking place but whether it is rapid enough to be worth considering.

I must first, however, guard against the drawing of a false inference from a fact which I have already brought to the reader's notice. Natural Selection still secures as its victims nearly half the persons born and from this it might be argued that the softening of the conditions of life has not gone far enough as yet to involve any danger: that civilisation has, after all, only brought it about that the percentage of the population eliminated in the present day is some 48 compared with about 57 some forty years back—a reduction of 9 per cent. or less. To this objection there is a very simple answer. Hard upon the softening of the environment, which reduces the amount of elimination, there follows (if pammixis works as I believe it does) a deterioration in physique. Hence, however easy life may be made, *as long as the process is gradual*, there will never be any great reduction of the death-rate. It is not the easiness of the conditions of life but the change in them, the change from hard to easy, that lowers the rate of mortality. And, surely, a reduction of 8 or 9 per cent. is no trifle.

II

STATURE

Statur in pre-historic ages

It was a fixed belief of many early peoples that their ancestors were bigger and stronger than themselves. The Romans looked back to a Golden Age in which everything was better than in their own time, as the things of their own day were better than those of years to come. Among modern theorists there is no such unanimity. There is a great belief in progress, that is, if we define it, progress in civilisation. And this has often been confused with improvement due to evolution. As to stature there is a tendency towards the view that men now are at any rate not inferior to their forefathers.

What we want is facts and it is curious what a dearth of them there is. It so seldom happens that average representatives of a class or a place are measured. They are usually picked men, soldiers, for instance, or undergraduates who go to be measured because they are proud of their height. And even if we had an ample supply of facts, the interpretation of them would still be very difficult.

To Dr Rahon we are indebted for a number of interesting measurements and calculations founded on them. According to him the Neolithic men in what is now France were not quite 5 ft. 4 in. in height, the "protohistoric" men were about $\frac{1}{3}$ in. over 5 ft. 5 in. and the Frenchmen of the Middle Ages were 5 ft. $5\frac{1}{6}$ in. or a shade over.[1] So the Neolithic men were by no means giants: the "protohistoric" men (I am not sure of the exact meaning of the term) were fairly tall, and the Frenchmen of the Middle Ages were a trifle shorter than the last named. Interesting as these measurements are, it may be questioned whether they throw much light on our present subject, since the representatives of the different periods do not represent one and the same people. Successive waves of migration swept over western Europe, each modifying the existing physical type. So

[1] See *Knowledge*, December 1894.

that the figures only dispose of the notion, if it still survives, that prehistoric men were all sons of Anak.

Dr Beddoe on stature

I pass on now to consider Dr Beddoe's elaborate inquiry into the *stature and bulk of man in the British Isles*.[1] It deals only with the stature of men of the present day but incidentally it illustrates the question we have in hand. "We find," he writes, "that wherever the Scandinavian element is proved to be strong by historical, topographical, or linguistic evidence, the stature is high. This is the case in Shetland, Caithness, the eastern lowlands of Scotland generally, in Dumfriesshire, Cumberland, Westmoreland, Lonsdale, Durham, Yorkshire (except Sheffield and Haworth), Lincolnshire, Nottinghamshire, and Leicestershire, and in the hundreds of Flegg in East Norfolk." These conclusions, founded as they are on a large number of measurements, we may look upon as thoroughly dependable. They make it clear that stature is very largely a matter of race, and they suggest that it is constant throughout long periods. It might be argued that height may possibly have increased or diminished uniformly throughout the British Isles, the short and tall races maintaining their positions relatively to one another. This is, no doubt, possible, but it is likely that a tendency that acted uniformly throughout a long period would leave good evidence of itself. We should find the men of the present day to be markedly either taller or shorter than the men of generations some centuries back. Now if we inspect the collection of suits of armour in the Tower, we find that the wearers must have been, most of them, neither dwarfs nor giants. There is one suit, it is true, made for a man of some 6 ft. 10 in. And Henry VIII. was obviously a man of great stature and bulk. But the collection as a whole suggests that height then, some three or four centuries back, was much as it is now. There has been a great deal of talk about the evidence supplied by armour of the inferior bulk of our ancestors as compared with ourselves. Guardsmen have inspected the Tower collection and have remarked that they could not get into many of the suits. Nor, we may reply, are a large percentage of Englishmen up to the

[1] *Memoirs of the Anthropological Society*, vol. iii. p. 384.

standard of height required for the guards. We cannot infer any great superiority for our own period from the fact that at the Eglinton tournament many of the performers found the ancient suits of armour much too small. They were, I believe, young men of birth and it does not require much observation to see that the scions of the upper ten thousand are in stature far above the average. When we come to consider the mean height of Englishmen, the facts, so far as they are known, are not so flattering to our conceit. If we take 5 ft. 5 in. as the standard of our army, then 210 per 1000 adult males in Northamptonshire are below it, according to Dr Beddoe; in Wilts and Somersetshire 260-280 per 1000; in Bristol 353, in Hertfordshire 417.[1] The smallness of the French soldier often strikes us, but in France only some 77 per 1000 are excluded from the army as being below the regulation height.

Race is a very important factor but it is certainly not the only one. Dr Beddoe's measurements put it beyond all doubt that the dwellers in large towns are inferior in height and weight to countrymen. The natives of Sheffield compare unfavourably with the men of the small towns and villages in the neighbourhood though their actual height 5 ft. 6·5 in. with shoes on is not so bad. The most depressing result comes from Spitalfields. Eighteen silk-weavers were measured and their average height (with shoes on!) was 5 ft. 1·4. But if any one doubts that stature may be reduced by unfavourable conditions, a walk or an omnibus ride through East London, will produce conviction without the aid of any figures. Indeed, to go from west to east in London, keeping one's mind on the subject of physique and one's eyes on the illustrations of it, is a melancholy experiment. It brings out too painfully how a strong race can be crushed and dwarfed by vice, bad diet, bad housing and all that goes to make up a vile environment. Even very definite under-feeding, it is true, may only postpone the age of growth. But if it passes a certain limit, or is too long continued, there is no recovery. The system loses its elasticity like a feather that is bent too far.[2]

[1] *Memoirs of the Anthropological Society*, vol. iii. p. 547.

[2] See *die Pubertäts entwickelung*, p. 23, by Professor Axel Key (pub. by Hirschwald at Berlin).

Potential and actual stature

But we must not lose sight of a very encouraging fact—that a marked distinction is to be drawn between the physique of the race and the actual physique attained by the individuals who represent it. The germ-plasm, as Weismann has made clear, leads to a great extent a life apart. The line of descent in a family is thus largely independent of the representatives of the family. The line is like a string of beads—to use Mr Galton's simile—and an individual is a pendant from one of them. True, it is difficult to believe that the health of the whole organism has no effect upon the reproductive cells. Still nature, intent upon the continuance of the species, seems not to allow them to share to the full the sufferings of the individual who is the trustee and guardian of the race. Their vigour remains, when, to use Weismann's term, the soma is weakened and impoverished. We must, therefore, be careful to define the word carefully when we speak of the degradation of the poorest of our town population. It is a degradation of the individuals and not of the race. That this is no fanciful distinction is shown by the fact that the Jews have emerged from the squalid life of the Ghettos in many ways a stronger race than the peoples among whom they live. It is in fact the Ghetto life to which they owe their strength. None but the strong could survive under such conditions. To apply this to the subject of this section, we must recognise that there is for each individual a potential and an actual stature. The stature of the race is the potential stature of the individuals that compose it, and if a foul environment dwarfs a particular generation, the next may, nevertheless, attain to the full development or nearly to it. This might be proved by experiment. If a child, untainted with the worst diseases, but sprung from a stock apparently as degraded as any in London, were from the first placed in a favourable environment, then there is reason to believe that he would attain to a physique of an utterly different order from that of his parents. Even when the experiment is made with boys already in their teens, the improvement is very great. But a perfect experiment of the kind suggested requires more than one generation. From conception to birth a child is a parasite on its mother. She is its whole environment. The un-

healthy condition of the mother may, therefore, affect the child in a way that is quite distinct from inheritance properly so called. This is a complicating circumstance, but it does not alter the main fact that in the foulest districts of our big towns it is not strictly speaking the race that has become physically degraded but the individuals who are its trustees—a clear and definite distinction.[1]

Stature of women in the higher social strata

In the light of this distinction I should be inclined to explain the increased height of the women of the wealthier classes in the present day. It is probably due to more favourable conditions, exercise, fresh air, and all that helps to make the most of the individual's physiological capital. There is reason to look in this direction for the explanation rather than to regard it as definitely a race improvement. For when a species attains to a higher standard of excellence, the cause at work is increased stringency of elimination. But there is no reason to suppose that anything of the kind has taken place in the matter of female stature. Improvement in the conditions of life is the main cause to which we must trace the change in question. At the same time it must not be taken for granted that increased height always means increased vigour. Rapid growth during boyhood often brings with it great weakness, though Professor Axel Key has shown that during the actual time of growth there is less liability to disease. High feeding and rest are required to tide over a time of weakness, after which a vigorous manhood may follow. But a tall race produced in this way is hardly likely to be as strong as one whose representatives do not pass through such a time of weakness. It is a great mistake to imagine that stature is a measure of vigour. On this subject I will quote the opinion of "Rifleman Harris," a private soldier who wrote a book describing his experiences in the Peninsular War. "All his villains were over six feet high, and he records that in the horrors of the retreat to Vigo the tall men were the greatest grumblers, the greatest eaters, and the worst fighters in the regiment. 'The tall men,' he says, 'bore fatigue worse than the short ones.'"[2] Harris himself was only 5 ft. 7 in., and he

Stature not a measure of vigour

[1] See chapter ii. where I have tried to explain it.

[2] Quoted in W. H. Fitchett's *Fights for the Flag*, p. 298.

may have been jealous; but stature is no proof of stamina. At the same time it must be remembered that tallness is relative: a tall Siamese would not be tall for a Scotchman. It is over-elongation, beyond the height proper to the race, that is often found to bring weakness with it.

Thus in some cases great height may be a symptom of degeneracy. It may result from the softening of the conditions of life, that allows weakness in various forms to survive. Assuming that the standard of height has risen within recent years in the upper classes—and there seems to be reason to believe that this is so—we must attribute it to the bettering of the environment. Certainly there has been no increased stringency of Natural Selection eliminating persons of smaller build. And these two are the only possible explanations. There is no third alternative.

Reproductive selection: supposed effect upon stature

For Professor Karl Pearson's *Reproductive Selection*, though it plays a very important part, cannot have the effect upon stature that he claims for it.[1] If it can be shown, he argues, that any character is correlated with fertility, that character will develop progressively quite apart from Natural Selection. Statistics founded upon observations on four thousand families chiefly of Anglo-Saxon race and one thousand eight hundred and forty-two of Danish race would lead to the conclusion that there is "a sensible correlation between fertility and height in the mothers of daughters." From this, he infers, that independently of Natural Selection there must be a continuous increase in the mean height of women. In forty generations (one thousand years) it would be raised $3\frac{1}{4}$ inches. "Reproductive selection—at anyrate in civilised man—seems a factor of evolution equipotent to Natural Selection, if indeed it be not prepotent."

Here is an attempt to dethrone Natural Selection and put it in a subordinate position. But Natural Selection, if it really is the regulating principle of evolution, must dominate all other tendencies. From its very nature it cannot tolerate a rival. In the present instance it is easy to make this clear. There are, broadly speaking, four possibilities only to be considered (1) fertility correlated with fitness in the offspring to survive; (2)

[1] *Natural Science*, May 1896.

fertility correlated with unfitness; (3) infertility correlated with fitness; (4) infertility corr lated with unfitness. Now it is obvious that only those mothers in whom the first of the four correlations is found will leave any great number of descendants. Hence fertility will tend to become associated with the characters that are best suited to the race, fertility without this association constantly tending to disappear through the working of Natural Selection. Reproductive selection has, therefore, to figure as a mere subordinate. The correlation between height and fertility, noticed by Professor Karl Pearson, is merely the machinery by which Natural Selection maintains the standard of height that in long ages of struggle has proved best.

I will now put down the conclusions with regard to stature **Conclus.** that seem to follow from the evidence obtainable. (1) Stature is to a large extent a race characteristic that lasts with little alteration for very long periods; (2) each person has a potential stature which through unfavourable circumstances may not be actualised; (3) the increase of height observable in the present day, especially in the daughters of aristocratic mothers, is due to a change of environment, *i.e.* the potential stature remains as it was; (4) that the change of environment which produces great stature is in many cases a lessening of the stress of Natural Selection, and that the gain in height and even bulk is often accompanied with a reduced power of bearing hardship.

If these conclusions are correct, as I hold, we have materials for forming an opinion on the question of degeneration. Since increase of stature is not necessarily any evidence of greater potential strength or even actual strength, we cannot base any arguments upon it. On the other hand, small stature in the degraded population of the squalid parts of our big towns is no proof of race degradation: the potential stature has not suffered, and vigour is being evolved by elimination on a large scale. Another phenomenon is more discouraging, viz., that what would formerly have been considered luxuries, are now apparently necessities for the children of the well-to-do. The

roughing, often including a very meagre diet, to which their grandfathers and even their fathers submitted as a matter of course, is now an impossibility; it is not merely that we choose to manage things differently. In their present comparatively luxurious environment they develop great vigour, and, to attempt a rough approximation, it cannot be said that there is any falling-off in the stronger 80 per cent. The change is in the conditions that seem necessary to maintain the vigour of all but a not very large percentage.

But since civilised society is an organism that is perpetually renewing itself from its base, the phenomenon does not necessarily imply degeneration. The conclusion we draw from it must depend on the depth to which the tendency penetrates. Is comfort beyond what was known fifty years ago a necessity to the uppermost strata of society only, or to the lower strata also? and here the answer is easy; the average standard of life has risen, and what were luxuries are becoming necessities. True, in some parts of Great Britain, notably in the most crowded parts of big towns, there is a high rate of elimination and race vigour is being maintained. But this is hardly likely to continue. The lower strata of society, the great recruiting ground of the upper, are undergoing the same softening process. We are, in fact, using up our physiological capital very rapidly, and we should be very foolish to let the maintenance of stature or even an increase of the stature actualised blind us to the fact.

III

DISEASE

Part played by disease in evolution

All species that survive, survive by adapting themselves to their environment. Bearing this in mind during our discussion of the question of degeneracy, we may divide diseases into two classes: those that doctors are successful in dealing with and those which, in spite of medical skill, often prove fatal. The

latter class maintains the strength of the race. When any of them have to be added to the former class, then there is danger of degeneration. The cause, however, of the danger is not the disease but the advance of scientific knowledge which frees the individual from the necessity of combating the ills of life for himself. As one instance of this we may take the adenoid bodies which form in the throat in the years of childhood, hindering breathing and consequently preventing the thorough oxidising of the blood. If left to develop, these adenoid growths would no doubt be not unfrequently the indirect cause of death, reducing, as they necessarily would, the power of the organism to fight any other disease that might attack it. Now it is becoming usual to remove them, as the operation is attended with little or no danger. The result is very often a great increase of vigour. But if we look to the interest of the race rather than to that of the individual, the result is not so satisfactory. There is a milder environment than formerly; for the doctor with his new discoveries is part of it. In this milder environment, it is no longer a necessity for the human organism to be able to breathe freely and well without assistance. As long as it can carry on respiration satisfactorily by the help of the doctor's intervention, that is enough. The organism in fact ceases to be self-dependent, to fight its own battle against disease, but is dependent on aid from others.

It may be objected to this view, no doubt, that the higher classes of animals have advanced to their present stage by preventing the direct incidence of Natural Selection upon the young: that among birds and mammals, of whom parental affection is so marked a characteristic, evolution has been carried to far nobler results than among reptiles and batrachians who leave their young to fight their own battle. This is quite true, but we leave out an important part of the system practised by wild animals. They pamper and coddle their young as far as they possibly can during infancy. But suddenly their affection ends, and the young things are pitched into the world for Natural Selection to choose from. The destruction, owing to protection during infancy, is more selec-

tive, less indiscriminate, but as ruthless as ever. Whereas among civilised peoples the stress of Natural Selection is weakened not only during infancy, but throughout life.

To elimination of the weak by disease much of the physical strength of Europeans is due. The circumstances of civilised life tend to foster a particular kind of stamina. The growing tendency under civilisation is to live herded together and thus there is far greater risk of infection than in former times, when population was sparse and the country was dotted with small villages or isolated habitations; when, too, the difficulty of travelling checked the spread of infection. The race has adapted itself to its circumstances. In spite of the large number of victims that fall to the various "civilised" diseases, there is a rapid increase of population. When, on the contrary, savage peoples are suddenly brought into contact with some disease that we have come to look upon without much alarm, but which is new to them, the consequences are often astounding. The fact is easily explicable on the theory that it is only by a constant elimination of the unfit that a race becomes adapted to its environment. The weeding out through a long series of generations of those who are unable to fight a disease at length produces a race who, though not immune from it, yet are, the majority of them, able to laugh at its attacks.

Tuberculosis

Tuberculosis has long been at work in England dealing destruction, but at the same time reducing its own power to destroy. Whether there are any definite records of earlier date I do not know, but I quote some of the earliest London bills of mortality.[1]

A D.	Deaths from consumption and cough.
1629	1827
1630	1910
1631	1713
1649	2387
1656	3184

No doubt the diagnosis was not in every case correct;

[1] I quote from Walford's *Insurance Cyclopædia*.

conscious of a certain vagueness, the compilers have lumped consumption and cough together. The marked increase observable may be very possibly due to the inaccuracy of the previous bills. It is astonishing that in the year of the decapitation of the king anyone should have found leisure and patience to count the victims of a particular disease. Whatever inaccuracy or incompleteness there may be, the broad fact remains that tubercular disease in various forms has been dealing death in England for centuries past. As to the proportion of the general death-rate referable to it now, authorities differ. According to the Registrar-General's report it was in 1896 rather less than one in ten.[1] But Dr Malcolm Morris writes in the *Fortnightly Review*, August 1898: "At least one in every eleven persons in these islands dies of consumption, and there are several other forms of tubercular disease which, if not equally fatal, swell the total of death." This does not give us any exact figure. Mr J. A. Gibson, in the *Nineteenth Century*, January 1899, apparently on the authority of Sir Thomas Grainger Stewart, says: "Tuberculosis accounts for at least one-sixth of the total death-rate."

If the disease is still so deadly, it may be argued that, after all, the race is not becoming superior to it through the working of Natural Selection. To this the answer is, that the crowded life in the big towns of the present day—thousands of families living in one-roomed tenements—makes the conditions very favourable for the germ. Consumption is now known to spread by infection. What is inherited is not the disease, but the weakness which pre-disposes towards it. The prevalence of the disease is, therefore, easily accounted for by the circumstances of modern English life. And if we wish to realise the progress made by the race in power of resistance to it, we have only to contrast with its limited activity in England the havoc it plays among savages. Consumption, small-pox, and fire-water are three things that civilisation generally brings with it. Against the first of the three we have been fortified by a sweeping process of elimination in past generations: against the two last

[1] See the Registrar-General's Report for 1896, p. lx.

by the same and other means. But the poor savage stands defenceless.

Diseases due to microbes, their reduced destructiveness

We must now again divide diseases into two classes—(1) those due to microbes, (2) those which have a different origin. In the Registrar-General's reports many of the former are called miasmatic, a term corresponding nearly or exactly to zymotic. But besides these, there are others which are now known to be caused by germs, notably tuberculosis, pneumonia, bronchitis. Sometimes in Arctic expeditions it is noticed that no one suffers from catarrh, in spite of all the exposure. And it is recorded that the inhabitants of an island on the coast of Scotland, in days when they were visited only once annually by a ship bringing supplies, found that they had each of them one cold and no more per annum, and that this happened always on the occasion when they had visitors—which they attributed to the fact that the vessel always came when the wind was in a particular quarter. But the truth has now come out.

Dividing diseases, then, on the principle just proposed we find very different tendencies in the two classes. The microbic diseases, viewed as a body, are markedly decreasing, some in prevalence, others in virulence. Partly science is warding them off—this is a rapid process—partly the race is slowly rising superior to them. Such plagues as the Black Death are things of the past. Small-pox and typhus claim but few, and, in each decade, fewer victims. The following figures are very striking:—

	Percentages of deaths due to Small-pox.	Typhus.
1839	4	6·3
1859	·8	3·3
1896	·1	0·1

Scarlet fever and typhoid, though still active, show a similar tendency.

Deaths to 1,000,000 persons living.

	1877.	1887.	1896.
Scarlet fever	585	282	178
Enteric fever (typhoid)	279[1]	185	166

[1] A change in classification makes the exactness of this figure doubtful. But the tendency is obvious.

But most noticeable of all is the large diminution in the number of victims claimed by tuberculosis in its various forms. In 1881 they numbered 2246, in 1896 only 1696 for each million of the population—a diminution of 550, or, for the whole population of England and Wales, of no less than 16,500.

Other diseases traceable to germs are on the up-grade, or have reappeared on the stage after being almost lost sight of. Diphtheria has much increased of late years; influenza, long almost forgotten, suddenly in 1890 swooped down on Europe. But no doubt many deaths really attributable to influenza were formerly put down to bronchitis. Hence the large reduction recently under the latter head. To the destructive pests that have improved their unenviable position we have to add pneumonia.

If, now, we are careful to reckon tuberculosis, pneumonia and bronchitis among the diseases due to microbes we find a reduction of no less than 936 in the annual death-rate for which this class of disease is responsible per 1,000,000 persons living. (I am comparing in this and subsequent cases the years 1881 and 1896.) This does not seem much out of a total death-rate of 17,100 in each million. But it must be remembered that the next few years are likely to see the tendency showing itself much more strongly. Influenza is possibly on the wane. Though diphtheria is on the up-grade, it seems probable that it will soon be humbled by science. Tuberculosis has already lost ground, and the new method of dealing with it—fresh air, high feeding and isolation—is likely to bring about a diminution more rapid than anything seen hitherto.

The diseases caused by microbes, therefore, have become less terrible, and are likely to suffer further discomfiture. That being so, the question arises: what diseases, if any, are taking their place? Old age, it seems, has not stepped into their shoes, for the deaths attributed to it show a decrease of no less than 163 for each million of the population. Moreover, under another head—debility, atrophy, inanition—there is a large reduction, no less than 230. This we may take to mean that every year there are fewer children starved. Even now we have not done with the

Other declining causes of death

large and important reductions. There are far fewer cases of convulsions than formerly; the victims are nearly all children, and the diminution, amounting to no less than 256,[1] may be put down to better feeding and better treatment generally.

We have now, therefore, found another set of reductions. Not only are the diseases due to microbes less prevalent or less deadly, but better feeding and better life conditions generally are diminishing the death-rate very largely among children.

Where, then, has there been an increase? But we must not expect to find the two tendencies—increase under some heads, decrease under others—balancing exactly, for there has been a great diminution in the total death-rate during the period we are considering, a diminution amounting to no less than 1786 for each million persons. And this might suggest that there are only insignificant increases, if we except those already mentioned—nothing, in fact, to balance the very notable decreases.

Constitutional diseases

However comforting this fancy may be, it is not borne out by the facts. If we remove tuberculosis in all its forms from the constitutional diseases in the Registrar-General's report, we find an increase of 223 in the death-rate attributed to those that remain. Bright's disease also has raised its annual rate, and by no less than 64; diseases of the circulatory system are becoming more deadly, showing an increase of 193. It may be objected that this tendency shown by the non-microbic diseases to raise the toll they demand, is due to the greater average length of life: it may be that longevity gives congenital defects time to tell. But this cannot be accepted as more than a very partial explanation of the facts.

It is evident that science is bringing about a great change. It is relieving men of the necessity of fighting against murderous microbes allied with any constitutional defects they may discover. The microbes are being banished: therefore whatever a man may have of inherited disease often attacks him unassisted. I assume that disease germs are more fatal in the case of those who have constitutional weaknesses. If we take a broad view, I think this is beyond dispute. It will hardly be denied that defective

[1] In this and other cases per 1,000,000 persons living.

chest development and other malformations predispose towards consumption.

What effect then, is the tendency just described likely to have upon physique? One thing seems plain; many congenital defects that formerly were able to eliminate, will lose their power, since they will have to work unaided: greater defect, wider deviation from the normal, will be possible, without the fatal limit being reached. Persons, therefore, of a lower standard of physique will survive and leave off-spring. Hence it follows that there must be some lowering of the physical strength of the nation. It is, of course, possible that it may be screened by the softening of the conditions of life, so that relatively to their environment men may be stronger. But barbarous or half barbarous races sometimes become part of an environment and then strength of that kind is not of much avail. Our ultimate decision as to the amount of danger in the present tendency must depend on our belief or unbelief in pammixis, as Weismann has called the cessation of selection. If pammixis, by merely allowing disintegration, can bring about loss of whole structures, the masterpieces of organic architecture, imitating in the work of undoing the cumulative action of Natural Selection in building, then the danger is very great. That pammixis has worked among civilised races with apparent cumulative power is, I think, shown by the great development of diseases. Take rheumatism as an instance. We can hardly believe that when it first appeared it had anything like its present malignity since a very slight attack would have left a primitive savage at the mercy of his environment—his enemies or his friends. Its power, therefore, has increased as the generations have passed. And yet men have been selected, as far as selection has continued, not for rheumatic tendencies but rather for their freedom from them. If, however, we deny that pammixis has what is equivalent to cumulative power and admit only that it can produce instability of important race-characters no longer protected by Natural Selection in their full development, even then the danger is not inconsiderable.[1]

Concl

[1] On the working of pammixis see the next section.

IV

DEFECT

Deaf-dumbness

Deaf-dumbness or deaf-mutism, as it is more commonly called, supplies such strong evidence of the tendency to degenerate, as soon as Natural Selection slackens, and illustrates so strikingly the working of heredity that it is impossible to pass the subject over. But it can only be dealt with in the most meagre fashion in the small space that I can allot to it. For further information I must refer the reader to the best authorities on the subject, to Dr J. K. Love's *Deaf Mutism*, to Mr E. A. Fay's *Marriages of the Deaf in America*, to Dr A. G. Bell's *Formation of a Deaf Variety of the Human Race* (published in the Memoirs of the National Academy of Sciences, Washington, 1883), and to the report of the Royal Commission on the The Blind, the Deaf and Dumb (1889).

The dumbness of deaf-mutes is due to their deafness, and the deafness is generally due to some abnormality in the labyrinth of the ear. In some cases the defect is congenital, in others it is adventitious, being traceable very often to some disease of the brain,[1] to scarlet fever or measles. "Those two groups of cases, cerebral affections on the one hand and scarlet fever and measles on the other, acccount for 57 per cent. of the acquired surdism in Britain, and scarlet fever alone accounts for 23·5 per cent. of the whole."[2] In England typhus is disappearing in the presence of improved sanitary conditions, and consequently adds but few to the number of the deaf. Not unfrequently deafness is due to adenoid growths, and there is no reason to suppose that the percentage due to this cause is decreasing.

It is important to distinguish congenital from acquired deafness, but it is no less important to recognise that in a considerable percentage of the cases where deafness is the consequence of disease there is probably some weakness but for which the

[1] Cerebro-spinal meningitis is a frequent cause of deafness in America.

[2] Dr J. K. Love's *Deaf Mutism*, p. 143.

disease would have passed off without working permanent harm. Those who have come to the conclusion that no acquired characters are transmitted can find unmistakable evidence of this in the fact that so-called acquired deafness tends to be inherited, though to a much less extent than deafness which is not the result of disease. To explain this, we might assume that the diseases which cause deafness find out a congenital weakness in the ear or the connected air-passages, and so destroy the sense, whereas they would have left a perfectly healthy organ unimpaired. Competent judges, however, hold that this view is in most cases incorrect; that measles or scarlet fever may ruin the most perfect of ears, though bad consequences are rendered far more probable by a general weakness of constitution. Nevertheless there may be—almost undoubtedly is—local weakness in some of the cases, in which inflammation destroys the sense of hearing: the upper air-passages may be much subject to catarrh, thus giving disease a better grip. This local weakness may be inherited, and may lead to deafness in successive generations. Again, hearing, already defective at birth, may be further reduced by inflammation due to fever, so that, at last, little of the sense may remain. Such a case would probably be put down as one of adventitious deafness. Whereas if the organs had been originally perfect, the reduction would have left a moderate power of hearing, and the person in question would not have been counted among the deaf. Moreover, a tendency to develop adenoid bodies undoubtedly runs in families, and these not unfrequently lead to loss of hearing. Deafness due to this cause, since not present in infancy, might easily be put down as adventitious, even if the adenoids were undetected. In this case, then, a congenital defect is transmitted, and the "adventitious" deafness is only a symptom of the defect. In fact, whether the evil is traceable to fever or to adenoid growths, we are able to account for the reappearance in the same family of a characteristic that is described in the returns as acquired.

We can now go on to consider deaf-dumbness in its relation to the question of physical degeneracy in civilised peoples. The first important point to notice is that the loss of hearing is in

many cases sudden. It does not gradually become less and less in a series of generations till it finally disappears, but the evil often begins with the birth of an individual in whom the sense is lacking. Very often his parents have in perfection the sense which is missing in him. Possibly if accurate experiments were made, some qualification of this statement might be necessary. It might be found that one or other parent had not perfect hearing in both ears.[1] Generally, upon investigation, it is found that the deaf man has some deaf relatives. Nevertheless what I have pointed out in the first part of the book is a fact, the importance of which cannot be reduced by any slight paring down that is possible, *viz.*, that an organ which has required thousands of generations to build up may be lost suddenly and completely through failure of heredity.

The working of heredity is very curious. If a deaf-mute is the first in his family who has suffered from the defect, if he has no deaf relatives, he is not likely to transmit the defect to his children, though it is quite possible that he may. Reversion will probably set in and reinstate the lost sense. If, on the other hand, there is a strong tendency to deaf-dumbness in the family, then it is very likely to be inherited. Moreover, a parent, who has absolutely perfect hearing, if he comes of a strain which is unsound in this point, is likely to transmit deafness, far more likely than a completely deaf man, who springs from a stock previously untainted. In the light of these facts, that have become known only in recent years, we can understand a great deal that to Darwin was obscure and perplexing. Deaf-mutism, the facts at his disposal seemed to show, was very rarely inherited and he was at a loss to understand the reason. "When a male or female deaf-mute marries a sound person," he writes, "their children are most rarely affected. Even when both parents have been deaf-mutes, as in the case of forty-one marriages in the United States and of six in Ireland, only two deaf and dumb children were produced."[2] Certainly the power of reversion is extraordinary, but it is

[1] *Marriages of the Deaf in America*, p. 7.

[2] Darwin: *Animals and Plants under Domestication*, vol. ii. p. 22.

breaking down, now that the experiment, so to call it, of the marriage of deaf-mutes is being tried with ever-increasing frequency. This will become clear if I reproduce one or two tables referring to the subject from Mr Fay's excellent book.[1]

Marriages of the Deaf.	Number of Marriages.	Marriages resulting in Deaf Offspring.	
		Number.	Percentage.
Both partners deaf . .	2377	220	9·255
One partner deaf, the other hearing	599	75	12·522
One partner deaf, the other unreported, whether deaf or hearing . . .	102	5	4·902
Total . .	3078	300	9·746

The number of marriages dealt with is sufficient to make the results dependable and the question of transmission is settled beyond a doubt. Mere coincidence cannot explain the facts, since when both partners come from sound families the percentage of deaf children is a mere fraction.

The greater percentage of marriages resulting in deaf offspring when only one of the parents is deaf is certainly remarkable. But when investigations are made, it turns out that deaf-mutes, even when they choose a hearing partner, usually marry into a family tainted with deafness, and this fact in a great measure explains the curious phenomenon that the figures present. Besides this, in the table just given, the congenitally and adventitiously deaf are all included without distinction. In the following table the two classes are separated and the figures do not give quite the same verdict. The last heading but one remains perplexing, but only ninety-eight marriages are dealt with, and it may be that this number is insufficient to justify inferences, when no information as to family tendencies is available.

[1] *Marriages of the Deaf*, p. 31.

Marriages of the Deaf.	Number of Marriages.	Marriages resulting in deaf offspring.	
		Number.	Percentag
Both partners congenitally deaf .	335	83	24·776
One partner congenitally deaf, the other adventitiously deaf .	814	66	8·108
One partner congenitally deaf, the other deaf, whether congenitally or adventitiously unreported .	120	17	14·165
One partner congenitally deaf, the other hearing . . .	191	28	14·660
One partner congenitally deaf, the other unreported whether deaf or hearing . . .	17	...	...
Both partners adventitiously deaf .	845	30	3·550
One partner adventitiously deaf, the other deaf, whether congenitally or adventitiously unreported .	195	17	8·718
One partner adventitiously deaf, the other hearing . . .	310	10	3·226
One partner adventitiously deaf, the other unreported whether deaf or hearing . . .	48	1	2·083
Both partners deaf, whether congenitally or adventitiously unreported . . .	68	7	10·294
One partner deaf, whether congenitally or adventitiously unreported, the other hearing . .	98	37	37·755
One partner deaf, whether congenitally or adventitiously unreported, the other unreported whether deaf or hearing . . .	37	4	10·811
Total . . .	3078	300	9·746 [1]

The next table that I shall quote brings out clearly the fact that it is the strength of the tendency in the family on which the question of inheritance depends.

[1] *Marriages of the Deaf*, p. 48.

One Partner Hearing, the other Deaf.	Number of Marriages.	Marriages resulting in deaf offspring.	
		Number.	Percentage.
Both partners had deaf relatives .	32	10	31·250
Hearing partner had deaf relatives, deaf partner had not . .	20	1	5·000
Hearing partner had deaf relatives, no information concerning deaf relatives of deaf partner reported .	11	2	18·182
Neither partner had deaf relatives .	56	3	5·357
Hearing partner had no deaf relatives, deaf partner had deaf relatives .	22	2	9·071
Hearing partner had no deaf relatives, no information concerning deaf relatives of deaf partner reported .	3	1	33·333
No information concerning deaf relatives of hearing partner reported, deaf partner had deaf relatives .	168	29	17·262
No information concerning deaf relatives of hearing partner reported, deaf partner had no deaf relatives .	106	1	·943
No information concerning deaf relatives of either partner reported .	181	26	14·365
Total . . .	599	75	12·521 [1]

The facts that have been collected by thoroughly competent investigators, mainly in America, enable us unhesitatingly to draw our conclusions. And this, though as yet the experiment has not yet been carried very far. Dr Graham Bell wrote in 1883: "We have received into our institutions only the first generation of deaf-mutes born from the intermarriage of deaf-mutes." [2] Before the education of the deaf and dumb, few of them married. Nearly 78 per cent. of all the marriages recorded in the reports of the American Asylum (the oldest institution in the country) seem to have been contracted since the year 1843.[3]

[1] See *Marriages of the Deaf*, p. 96.

[2] *Memoirs of the National Academy of Sciences*, vol. ii. p. 215. [3] *Loc. cit.* p. 202.

The danger, then, is due to the education of the deaf and dumb, and philanthropy is bringing about results that cannot but be regarded as deplorable. The following figures are very suggestive. In the United States (a comparatively new community, constantly recruited by settlers with, presumably, hardly a deaf-mute among them) there is 1 deaf and dumb person to 1514 of the population, whereas in Great Britain the proportion is 1 to 1969, and in Spain 1 to 2178.[1] These figures must be viewed in connection with the statistics of education. In the United States 1 in 5·75 of the deaf-mute population is an educational institution, in Great Britain 1 in 7, in Spain only 1 in 36.[2] We require further to know, if possible, the date at which in any particular country the education of deaf-mutes became general. In the United States there were thirty-three educational institutions for the deaf and dumb founded before 1870, and in Great Britain only twenty-three. In our country till 1891 the education of deaf-mutes was left mainly to charity.[3]

No doubt consanguineous marriage is another factor. This probably has much to do with the fact that when civilised countries are arranged in order according to the percentage of deaf-mutes in the population of each, Switzerland heads the list. The inhabitants of each mountain valley are to a great extent isolated. In flat countries there is more freedom of intercourse, and there is consequently less intermarriage between relatives. In Belgium the deaf-mute population is only 1 in 2247, though 1 in 3·2 is being educated. The Roman Catholic religion, by forbidding marriages between cousins, apparently keeps down deaf-mutism. In Berlin among the Roman Catholics the proportion of deaf-mutes is 1 in 3000; among Protestants 1 in 2000; among Jews, with whom intermarriage with blood relations is frequent, 1 in 400.[4]

[1] See *Deaf Mutism*, p. 217.

[2] I have obtained the materials for these figures from *Deaf Mutism*, p. 217, and the *Memoirs of the National Academy of Sciences*, p. 253.

[3] See *Deaf Mutism*, p. 334. But something was done by the School Boards as early as 1879. See the Report of the Royal Commission on the Blind, the Deaf and Dumb, pp. liii. and liv.

[4] See Dr Love's *Deaf Mutism*, p. 119, on the influence of religion on deaf mutism.

The following table shows at anyrate that *where the taint of deafness already exists*, consanguineous marriage increases the likelihood of transmission.

Marriages of the Deaf.	Number of Marriages.	Marriages resulting in Deaf Offspring.	
		Number.	Percentage.
Partners consanguineous .	31	14	45·161
Partners not consanguineous or no information concerning consanguinity reported	3047	286	9·386[1]
Total . .	3078	300	9·746

We must, therefore, be careful not to attribute the whole of the evil to the fact that the deaf in recent years have been more generally educated, and consequently have more frequently intermarried.[2]

But though the frequency of deafness is, no doubt, in some communities largely due to consanguineous marriages, any increase of frequency must be due to some other cause, since there is no reason to believe that marriages between relations have become more common. We must, therefore, conclude that where congenital deafness has recently grown more prevalent, it is traceable to the systematic education of the deaf which has been proved to result in a great increase of the marriage-rate among them.

There is no doubt that there is a serious increase of the tendency to deafness, but it is quite possible to quote figures

[1] *Marriages of the Deaf*, p. 108.

[2] Mr Huth in his book, *The Marriage of Near Kin*, concludes that no bad results follow from such marriages. Rigid Natural Selection among domestic animals, no doubt, makes inbreeding even beneficial. When Natural Selection is less stringent, as among men, serious evil often results.

that obscure it altogether. In England and Wales the ratio of the deaf and dumb to the general population was in

1851—1 to 1738
1861—1 to 1640
1871—1 to 1972
1881—1 to 1954
1891—1 to 2043[1]

In these figures the congenitally deaf and those whose deafness has resulted from disease or accident are counted indiscriminately and the reduction due to the decrease and better treatment of typhus, scarlet fever, measles and other diseases has more than counterbalanced the increase of congenital deafness. There is every reason to believe that this is the explanation of the figures, though absolute proof is not as yet obtainable in England. However, the facts that have been established in the United States leave no doubt as to the tendency.

The specific infectious diseases that often leave deafness as a legacy are always at work and it is important to understand what results follow from their working. They often find out a general weakness of constitution of which the resultant deafness is a symptom. Almost certainly in some cases they bring to light a local original defect (such as a tendency to catarrh in the air passages connected with the ear). By producing deafness in days when the deaf seldom left any progeny, they helped to maintain the standard of physique. In the present day they simmer in fetid corners instead of sweeping over whole towns, districts or countries. And thus the unsound are not so much hampered by a congenital defect as they were in the days of raging epidemics and rudimentary science. Moreover the practice of removing adenoids with the result that the sufferer, in many cases, gains much in strength, must eventually increase the tendency to adenoids and so to the deafness that often results from them.

Civilised peoples are therefore in the presence of a grave danger. The amount of deafness, potential or actual, is in-

[1] *Deaf Mutism*, p. 201.

creasing, partly through the diminution of the diseases that formerly checked it by an eliminating process, but more through the growing frequency of the marriages of the deaf. Dr Graham Bell fears that a deaf variety of the human race will be formed. Certainly variety, not species, is the word since there is no intersterility between the deaf and sound persons, and this fact enables the defect to spread with very great rapidity. The remedy proposed by Dr Graham Bell, that the deaf should never marry the deaf is, in the light of the facts that are now known, of no avail. Dr Love finds consolation in the fact that the deaf are less fertile than those who are possessed of hearing. But the inferiority is but slight and is likely to be bred out altogether, those in whom it is not found being the parents of most of the next generation of the deaf. As to the remedy, common humanity forbids that there should be any return to the old system which left the deaf helpless and uneducated. The only possible means of checking the evil, therefore, is to discourage them from marrying by exhortation and by the plain statement of the facts. In the last resort, legislation is possible.

Nothing brings out more clearly than the increase of congenital deaf-dumbness, how important Natural Selection is if a species is not to lose rapidly the faculties and powers it owes to the slow process of evolution.

Civilisation does not tend to produce good teeth. The "heirs of all in the ages in the foremost files of time" may, only too many of them, look with envy at the teeth of the savage. I give some statistics to emphasise facts that are perfectly well known. The teeth of children in the pauper schools of London have been examined and it has been found that out of 3145 inspected there were only 707 cases in which "neither fillings nor extractions were required." "Even this number, 707, would have been much less, had not 148 children between the ages of nine and seventeen in one school had 256 permanent teeth removed by the medical officer."[1]

Teeth

Only between 17 and 18 per cent. possessed of sound teeth

[1] *The teeth of pauper children*, p. 6, by R. D. Pedley, F.R.C.S. (reprinted from the *Brit. Journal of Dental Science*).

if we count the 148 among the unsound as we are bound to do, though most were still quite young! What would the percentage have been after, say, they had passed the age of twenty, assuming that defective milk teeth were replaced by defective permanent teeth.

I now give some figures from a paper by Mr Sidney Spokes which show what equipment of teeth the English public school boy has. Five hundred and sixty boys of an average age of thirteen years and seven months were reported on. The figures refer only to the permanent teeth, and therefore do not, strictly speaking, present a companion picture to those last quoted. "Only thirteen had sound dentures, but ten of these were in boys under fourteen years, several of whom had not yet erupted the bicuspids and second molars; seventy-one had been made 'artificially sound.'" Among boys of the upper classes, then, things are, if we make a rough comparison, as bad as they are among pauper children. Only 2·3 per cent. had perfectly sound teeth, and even in some of this small number unsoundness might show itself when the bicuspids and second molars made their appearance! [1]

In pauper children the whole system may have been so reduced by underfeeding during infancy, that the teeth may have been affected, and the diet of the rich may not be always perfectly judicious. But for the main cause of the defect we must look elsewhere. Those who have bad teeth are no longer eliminated. Dentists and cooks (I hope to be forgiven for coupling them together) have brought about this result. Adopting this view, we explain deaf-muteness and defective teeth on the same principle. Both are congenital defects. But in the former case the loss is complete, in the latter only partial. Complete absence of teeth would probably be accompanied by very imperfect development of jaw, and no skill of dentistry could make it good. Moreover, English cooks seem, many of them, anxious to retard the deterioration of the race by sending up joints in a state of barbarous toughness. So that teeth are not likely to disappear with the rapidity with which a race of deaf-mutes might be formed.

[1] See *Transactions of the School, Dentists' Society*, vol. i. No. 1.

For our purpose it is important to discover—(1) whether a large percentage of the men and women of civilised nations have defective eyesight; (2) whether the defect is congenital; (3) whether the percentage is increasing. Eyesight

Hermann Cohn[1] has tested the sight of thousands of school children at Breslau, and he finds that sight is much better on the average than it was thirty-three years ago, the percentage of schoolboys and girls having abnormal vision being 19·2 in 1865 and only 10·5 in 1898. The improvement is so enormous that it is impossible not to suspect that there has been error somewhere. Though the test has been the same, the conditions may have been in some way different. Cohn himself frankly suggests a cause of error. There has been competition between classes, one wishing to "over-trump" another. And when a boy who is undergoing examination is trying to make out figures at a certain distance, he may be prompted by one who is standing nearer![2] This might account for results that are otherwise inexplicable. The author in fact throws but little light on the subject of our inquiry. The question of congenital defect seems not to occur to him. He is an enthusiast who attributes the whole evil to unhealthy conditions, and who hopes to remove it by improvement in the lighting of schools, by the use of proper glasses, and generally by better treatment of the eyes. No doubt he has done good work by directing attention to the importance of such things, but he does not go to the root of the matter.

Much valuable information is to be obtained from the report published by Dr Brudenell Carter on *The vision of children attending elementary schools in London.*[3] The sight of 8125 children was tested, and it was found that only 39·15 per cent. had normal vision in both eyes. This sounds very bad, but in most cases the defect amounted only to subnormality. The bald statement of the percentage would, therefore, give a very erroneous impression. Adopting the standard below which candidates for the

[1] Die Schleistungen von 50,000 Breslauer Schülkindern. Breslau: S. Schottlaender, 1899.

[2] *Loc. cit.* p. 60.

[3] Printed by Messrs Eyre & Spottiswoode.

Indian Civil Service must not fall, Dr Carter concluded that only 2·8 per cent. of the children examined had *excessive* short sight.

Before we attempt to analyse the figures, it must be observed that what normal vision really is has never been ascertained; it is explained to mean "the power of sight commonly possessed by healthy people in civilised countries, and the definition of the term is that the person to whom it is applied is able to see an object of given magnitude at a given distance."[1] But inequality of vision in the right and left eyes is a question of fact, independent of any arbitrary standard, and it was found that 12·5 per cent. had normal vision in the right eye and subnormal in the left; 8·6 had normal vision in the left eye and subnormal in the right.[2] From this we may fairly infer that "normal vision" does not represent an absurdly high standard.

We must, further, be careful not to lump together all kinds of abnormal vision. The common causes of bad sight are hypermetropia (where the axis of the eyeball is too short, so that a clear image is never obtained without the effort of focussing) and myopia (where the length of the eyeball is excessive, with the result that when parallel rays fall upon the eye they focus in front of the retina). This is properly called "short sight," "a condition," as Dr Carter puts it, "in which the eyes have good vision *within* but not *beyond* some specified distance, according to the degree of the defect." In England some small degree of hypermetropia is almost universal in childhood. "As the eyeball grows in the course of natural development, it often attains more correct proportions, and the hypermetropia may consequently diminish, but it seldom entirely disappears."[3] As to short sight, "Ophthalmologists are more and more coming to regard myopia as a state which may often be aggravated by injudicious methods of using the eyes, but which, in the great majority of instances, depends greatly on predisposing causes, and which, when these are in active operation, is liable to increase, notwithstanding all the precautions which can be employed."[4]

1 Dr Carter's Report, p. 3.
2 *Loc. cit.* p. 4.
3 *Loc. cit.* p. 6.
4 *Loc. cit.* p. 7.

We see now (1) that though sight in London Board School children is very often defective, it is seldom seriously so; (2) that the defect is believed by ophthalmologists to have in most cases a congenital basis, though it may be aggravated by bad conditions.

Dr Carter concludes by stating his conviction that many cases of subnormality cannot be accounted for by the imperfection of the apparatus of accommodation, the apparatus for throwing the image on the sensitive plate, but that the retina must be at fault. The failure of the retina he attributes to want of practice in examining things closely. But why should there not be congenital defect here also? If it occurs in one part of the optical machinery, it is likely that it should occur in another. One fact which he mentions is clearly a sign of the times. "Both convex and concave spectacles are quite commonly used by children requiring them, and parents seem to have been alive to the fact of defective vision in its higher degrees and to have sought assistance from hospitals for its relief."[1] The wearing of spectacles by the children of the poor is surely a very recent phenomenon. In former generations no such aid was obtainable, and to this we may attribute the fact that the defect as a rule amounts only to such mild subnormality as will not put a man at a great disadvantage. There must have been some elimination of a high degree of bad sight, probably in part through the agency of sexual selection. The conditions have only in recent years become suitable for the spread of serious abnormality.

Summary

The subjects discussed in this section have brought out very clearly the working of pammixis. A character that is no longer protected by Natural Selection is wanting in some individual. From this no visible result may follow for a generation or two. But there has been a loss of stability: the descendants of this individual have in their pedigree an ancestor with the defect in question and reversion may revive it. A few more cases of the same defect in the same family or small group, and stability is gone. At first the species seems to suffer but little: defect shows itself in an individual here and there. But when once the

[1] Dr Carter's Report, p. 14.

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species has become to a large extent permeated, then it loses its power of resistance. As each new generation is born there is less and less chance of reversion to the old type. At last the absence of defect becomes exceptional, and what was abnormal becomes normal.

We must view this process in connection with the fact that the loss in an individual is often total; the sense of hearing may be through congenital defect entirely wanting. A power which took thousands of years to bring to perfection is gone at one blow. I have written above on the large variations by which Natural Selection seems in some cases to work. But size is a matter of degree and no one imagines that such an elaborate organ as the stag's antlers could be developed in their completeness suddenly without intermediate steps. And so with the sense of hearing. But failure of heredity may suddenly and at once cause the disappearance of all this accumulated perfection. In earlier chapters I have contended that heredity is always tending to fail, and is only maintained by the most stringent Natural Selection (chap. ii. and chap. iv. sec. iv.).

The variations, then, which pammixis finds ready to hand are larger than those which Natural Selection has for constructive purposes. And besides this, stability, when it has received a number of shocks, is lost rapidly. These two facts must be viewed in connection. Pammixis compared with Natural Selection may be a clumsy manipulator, but it has more material at its disposal. Total or great defect in individuals followed by loss of stability in the group or species may clearly produce great results. It is easier to pull down than to build. Pammixis is able to sweep away all that has become superfluous and so produce adaptations to new conditions.

V

NERVE STRAIN

There is a great deal of talk about nerve strain as the distinguishing feature of modern life. Without, for the moment,

disputing the truth of this altogether, I cannot but think that there is some exaggeration through the omission from the calculation of the force of habit. It is the unfamiliar danger, magnified ten times by the imagination, that tries the nerves. What is familiar ceases to be terrible. A dweller in the country when he first tries bicycling in London fixes a glassy eye on every vehicle and every side street as a possible source of danger. But the habitué proceeds unperturbed upon his way. And so with any causes of worry and anxiety. An architect who has once been hardened does not care though he is responsible for a building that will disfigure the landscape for ages. A minister for foreign affairs is able, probably, to decide without a tremor questions on which peace and war depend, because such questions present themselves so often. And thus the racket of modern life is not so trying as it might be thought to be. Yet no doubt the armour of habit does not fend off the whole of the evil. Though you may learn to sleep with the night-long rumble of vehicles outside your window, yet probably you do not sleep so soundly as you would if there were nothing to disturb you till the farmyard woke up.

The classes, if any, that suffer

So much for the amount of the nerve strain where it exists. But we cannot possibly deal with the general question unless we first decide what classes of the population are sufferers from the high tension of the latter half of the nineteenth century. Undoubtedly it is the professional and business men. The keener competition and the highly speculative character of business in the present day must cause a wear and tear of nerve tissue out of proportion to the actual work done. Nor must we leave out of consideration the strain that competitive examinations put upon the boys of the higher social strata, though it is much mitigated by the healthy environment in which they work. But when we are considering the future of the race, the conditions under which the small percentage of the population forming the upper classes live are of very small account. What we want to know is whether life is hard or easy for the vast mass of the people from whom the upper classes are constantly recruited. And thus we come back to a subject with which I

have already dealt and which, therefore, requires but very brief treatment now.

No doubt if we compare the England of 1899 with the England of forty or fifty years back we cannot help recognising that a strain is put upon the children of the poor that they were free from then. They are kept at their lessons with much greater regularity, and work in crowded and often ill-ventilated rooms takes the place of play about the cottage door or on the village green or of light work on a farm, perhaps no less healthy than play. Moreover, our population is crowding into big towns and their new homes are less healthy than the old. So far life is harder. But the evils attendant on life in large towns and a crude method of dealing with the problem of education are likely to be very much mitigated, have, in fact, already been mitigated to some extent. On the whole, we may say that life is easier for the poor now than it has ever been before, unless we travel in imagination back to ages of which it is impossible to know much. Food and clothing have grown cheaper and wages have gone up. Those are two great facts that cannot be counterbalanced by anything that can be thrown into the opposite scale. Moreover, there is no doubt that the British working man not only works shorter hours than formerly but—a fact that cannot be mentioned on a political platform—is much inclined, even during this shorter time, to work at low pressure. No less true is it that much less work than formerly falls upon the wives of working men. Not so very long back they used commonly to work in the fields. Now such a thing is very rarely seen. I believe, if we correctly picture to ourselves the average or typical life of Englishmen or Englishwomen of forty years ago and compare it with the type or average of to-day, we shall find an increase of comfort rather than of nerve strain. And as the inventor multiplies more and more the effectiveness of a man's labour, there will be a further increase of comfort. Life will be softer, and as a consequence, unless some new factor comes in, the race will be softer.

Insanity It is sometimes maintained that the alarming increase of insanity that has taken place since 1871, the earliest year for which

statistics are available, is due to the strain of modern life. But this explanation rests on what I cannot but consider a false assumption. To understand the facts we must look elsewhere. Strange as it may appear, there is less practical isolation of persons of unsound mind than formerly. Many after a period of confinement leave the asylum "cured." This being the case, the principles enunciated in the sections dealing with disease and defect will account for a great deal of the increase of insanity.

VI

ALCOHOL

Love of strong drink characteristic of most races

Most races take delight in strong drink. Only after many centuries of the use and abuse of it do they at last attain to moderation. The English from early times have been noted for their habit of drinking. Even on the eve of the battle of Hastings they gave themselves up to carousing, unless this is a Norman slander. We read in Shakespeare: "Your Dane, your German, and your swag-bellied Hollander are nothing to your English." When spirits came in there were advertisements posted up at the doors of inns: "Here you may be drunk for a penny, dead drunk for twopence." At the present day we insure at any rate that drunkenness shall not be cheap, for the duty on a gallon of spirits is 10s. 6d., whereas in France it is only 2s. 10d. The very interesting paper recently issued by the Board of Trade gives us some very striking figures as to the consumption of alcohol in the United Kingdom. There is but little wine drunk, only rather less than two-fifths of a gallon per head per annum. Beer is the staple drink and on the average we get through, each of us, $31\frac{3}{10}$ gallons. Of spirits we average $1\frac{1}{50}$ gallons. If this were divided equally over the whole population, the weekly allowance would not be much. It would amount to rather less than five pints of beer and a little less than one-sixth of a pint of spirits. Ten glasses of beer and two small glasses of spirits per week! But it must be remembered that the

female sex exceed in tea rather than in alcohol. The male half (strictly, considerably less than half) of the population are responsible for most of the alcohol consumed. Then, boys under fifteen, say, drink very little alcohol, and there are besides a large number of adult teetotallers. It is evident, therefore, that the males over a certain age, who are not abstainers, get through a large amount of alcohol per head.

Percentage of deaths due to alcohol

How does this affect the evolution of the race? Mr Archdall Reid in his very interesting book, *The Present Evolution of Man*, has a very simple answer to the question. There is a constant elimination of those who have an over-strong tendency to the use of alcohol; thus a more sober race is gradually evolved, and, in fact, the sobriety of a nation is proportioned to the time it has been accustomed to alcoholic liquors. The question, however, is really a very complicated one. First, as to the number of deaths due to alcohol. Mr Reid says one in every ten. The Registrar-General's annual summary for 1897 gives the annual average number of deaths due to alcoholism for the decennial period 1887-1896 as 454 out of a total of 88,594. This is only one in 195. But it must be remembered that the 454 are those only of which alcoholism is the immediate traceable cause. Thus the huge majority of cases are attributed to something else. Habitual soaking, even when not carried to the extent of actual intoxication, is ruinous to the constitution, more so, it is said, than an occasional drunken orgy. Such soaking will leave a man at the mercy of some constitutional weakness, which otherwise would not have been fatal, or might perhaps have remained unnoticed.

Besides this it must be remembered that drink produces a state of intolerable misery in the drunkard's household, leading often to the death of his children through insufficient food, actual cruelty, or any of the evils that may arise from the degraded habits of the father or mother. If the deaths of the children that are traceable to the drunkenness of their parents be put down to the account of alcohol, then alcoholism in this extended sense has to answer for a very large percentage of the annual deaths. Even if we do not count in the children who are

indirectly victims, the percentage is great. Probably Mr Archdall Reid is not far wrong in attributing one death in ten to this cause.

Influence of alcohol upon evolution

Degrading as the excessive indulgence in alcohol is to the individual, it admits, I believe, of no doubt that drink tends to maintain the physical strength of the nation, and at the same time helps to develop the moral qualities on which civilisation depends. The two tendencies work side by side in the same society. When it is the fashion to drink much, all who have not the strength of mind to resist the fashion have to submit to a physical test that tries the heart, digestive organs, and the whole constitution. The old-fashioned dinner with no heeltaps is typical of the manners of a former day when it was expected of everyone that he should drink, and drink much. And it is obvious that the frequent application of such a test of physical stamina must cause the disappearance of a number of weaklings. And if the process were continued in each generation through several centuries, it is evident that the race, though many of its representatives might be morally degraded through excess, would be characterised by physical strength, always assuming that the conditions of life were in other respects reasonably favourable. But no constitution can for very long stand largely excessive potations repeated at short intervals. There has, therefore, always been a selection of those who were capable of self-restraint, as well as of those who had physical powers of resistance. Very often the two tendencies are well illustrated by one and the same person in whom we find the physical strength that makes light of no small amount of alcohol, and the self-control that pulls up short when near the dangerous margin. But in the present day we see the one tendency more actively at work among the upper classes, while the other acts with diminished, but not very much diminished, potency among the lower. The greater consumption of alcohol in the year 1897, as compared with 1885, we may put down to an increase of wealth, which has more than counteracted the growing tendency to moderation. Among people of any social standing drunkenness is altogether tabooed, moderation is the fashion. And thus those survive who have self-

control enough to resist the temptation to drink, or who have little inclination in that direction.

This selection for moral stamina has, I believe, already borne effect, and the modern English gentleman would be unable to hold his own among the old three or four bottle men even if he were allowed a reasonable time for training. Men who combine poor physique with great strength of character are at the present day not uncommon: one cannot help respecting and admiring them. Such men have been made possible by the growing tendency to self-restraint; knowing exactly where their weakness lies, by care in diet and by making the most of all the strength they have, they are able often under rough conditions to cut a better figure than those who may be looked upon as products of the older and slowly disappearing tendency of evolution. Such men are able by the help of long-continued training and by studying the laws of health to go through a trying campaign without breaking down. It is probable that men of this stamp will be still more common in the future. When there is moral, not physical, resistance to alcohol there is, of course, an evolution of moral, not physical, strength. In the present day evolution is proceeding on moral lines and is likely to continue to do so, unless the tendency is counteracted by influences not as yet perceptible. But though the main drift of evolution at the present day is, as I have said, towards a higher morality and a lowered physique, yet it is possible that there may be found means of mitigating the evils that seem destined to accompany the gradual ennoblement of human character.

We have by no means done with the subject of alcohol. Not only does it eliminate those who tend to alcoholism, but many besides who are in various ways ill adapted to civilised life and drown the bitterness of failure in drink. This I shall discuss in the chapter on moral evolution.

VII

SUMMING UP OF THE EVIDENCE

Adaptation to environment only a matter of time

I have now given a good deal of evidence on the subject of physical degeneracy and it is time to sum up.

In the first place, it is beyond dispute that, as change of conditions gradually makes certain characters and qualities unnecessary, or necessary only in a dwarfed condition, those characters and qualities will tend to dwindle. The barnacle has lost its eyes and its power of motion, the sacculina has lost every feature that gave it grace and dignity, the apteryx has but vestiges of wings, and the fish of the Kentucky caves have become blind. In the same way man must become adapted to his environment. In a world, where adaptation is the rule, it is not likely that there should be a great and inexplicable exception. Since Natural Selection is still at work even among the most civilised races, it is more reasonable to attribute their strength to that, than to say that they have somehow become or made themselves superior to the laws that prevail throughout the rest of the organic world. As Darwinians we are bound to believe that man will in course of time, however we may account for the process, lose qualities he can dispense with. Thus stated, however, the fact has only an academic interest; it has no practical bearing. It leaves unsettled what we most want to know, viz., whether the degeneration is likely to be rapid or slow. If it will not begin to be felt till ten million years have passed, then we are all of us so far practical politicians that we shall not trouble about it. If, on the other hand—to take the other extreme—each generation is likely to be appreciably feebler than the preceding one, then we shall feel that there is some reason for depression.

Protected and unprotected qualities

In forming our judgment, we must never lose sight of a fact which the evidence brings out most strongly; there are certain organs which in the civilised man must be sound, though not necessarily so vigorous as in his barbarian ancestors. Among these we may count the heart, stomach, liver, muscles, nerves.

On the soundness of these the general vigour of the organism depends. For example, no artificial peptonising of food is ever likely to relieve it of the task of assimilation. On the other hand, a man who is bald at thirty, whose teeth are artificial, and whose eyesight is far from perfect, may be vigorous and efficient under modern conditions. Now we may feel sure that those qualities which are essential to general efficiency will die harder than those which, in their perfection at least, have become mere luxuries, if we may so describe soundness of teeth and keenness of sight. The former can *at the fastest* degenerate only at a rate proportionate to the *general softening* of the environment; the latter may have a velocity of their own since they have ceased to rank among things of first-rate importance.

Thus we can see clearly that certain powers are likely to be lost rapidly as compared with others. This, however, tells us nothing about the absolute rate; the number of generations in which any given organ will have dwindled so far as to lose, say, half its efficiency. Such definiteness is from the nature of the case unattainable. But, by the distinction just made, much light is thrown on a very interesting question. We often hear of the permanence of race characters. These permanent characters are those that are maintained by the environment. If Englishmen are now, as regards their most salient qualities, what they were in the sixteenth century, it is because the same qualities are still in demand. To bring together two more distant dates, if men who may be regarded as the prize products of civilisation are capable when need arrives of fighting as fiercely as any barbarians, that is because modern civilised life demands the quality of combativeness in a high state of development. We have everywhere a competitive system. In trade, speculation, the professions, education, athletics, there is a struggle to defeat rivals or to fight against hard conditions. Law and honour forbid the combatants to inflict bodily injury upon each other or to resort to sharp practice of any kind; this is the same spirit of humanity that in real war spares and tends the enemy's wounded. Trade between nations is largely of the same nature as war. It it is not merely a friendly exchange but a struggle between

rivals to get possession of the neutral markets. Modern life, generally, in fact, is very largely conflict, under humane conditions it is true, but still conflict. Hence, I believe, the survival of physical courage. It is true that a man in a civilised state may thrive without much of it. But as a general rule the combative spirit rests on a certain basis of physical courage, is, in fact, correlated with it. In the same way we may hold that vigour has become correlated during the evolution of the race with a certain stature. The vigour is still in demand, while a smaller stature is all that is indispensable. And the vigour may protect its correlated yoke-fellow from diminution.

We must now see whether any evidence of the rate of deterioration of the comparatively unprotected characters such as eyes or teeth is obtainable.

Where the range of variation tolerated is great, degeneration will be rapid

In discussing pammixis[1] I showed that retrogression may be much more rapid than progressive evolution. An organ that has taken many hundreds of years to build up, *e.g.* the horns of cattle, may suddenly and totally disappear or leave behind a mere vestige. When the hornless breeds of cattle were being formed, selection, so far from protecting, made war upon the disappearing organ. We cannot in the human frame find any structure which is completely "unprotected." Even the tendency to baldness, if it makes its appearance before a certain age, may be checked by sexual selection.[2] Nevertheless the incidence of Natural Selection upon some characteristics has been weakened sufficiently to set up a state of instability. There is a great range of variation, notably in the case of sight. There are persons who, through congenital defect, have to hold a book within two inches of their eyes: there are others who could read the print of the same book at any distance between six inches and four feet. Teeth in the same way vary between complete soundness and almost complete unsoundness. *Where the survival limit is so very low, we may expect a general deterioration and a rapid one.* It is possible that the deterioration will not be

[1] See p. 94.

[2] The author of *Degeneracy* in the *Contemporary Science Series* has given as evidence a great many facts which have no bearing on the question. Monstrous forms which are certain to leave no progeny, are in this connection not worth mentioning.

much felt in either case for two or three generations. Optical instruments may possibly improve more rapidly than average eyesight deteriorates: there is, in fact, the race between the softening of the environment on the one side and degeneration on the other, and when the former wins, the latter is not likely to make itself felt. Science may possibly, for a time, outstrip deterioration. But the victory of science only brings nearer the day of ultimate defeat, since the more rapidly the standard is lowered for any organ, the greater the resultant instability: in fact the more rapid the process of degeneration.

There remain the other organs and qualities which I have described as protected, because they are correlated with general vigour. They have lasted during centuries of civilisation and it might be thought that there was no need to feel any alarm on their behalf. However, during the last few decades the softening of the environment has been so very rápid that even here the deterioration is likely to be appreciable though less rapid than in the cases we have just considered. Medical science seems likely to get an almost complete mastery of the germs of zymotic disease, and hitherto these germs, allying themselves with some congenital defect, have caused an enormous amount of elimination. If the germs are banished, the congenital defects will work unaided, that is, the standard of physique will be lower. In addition to this, great efforts are being made to banish the crises on which vigour depends. Even those whose ordinary life is a comfortless desert, often find themselves during sickness in an oasis of comfort. As time goes on, this will be more and more the case, since science and humanity forbid that it should be otherwise.

Other races supply a criterion

Here again it may be said: what matter if the strength of the barbarian has been lost? The conditions of life are much easier and so nobody wants it. This argument is highly plausible, but utterly unsound. History tells of numbers of races that have disappeared because they lost their vigour and consequently were conquered by others who, though less civilised, were harder and stronger. Altogether apart from such questions, what we may call an artificial vigour, due to

a progressive softening of the environment, is a poor substitute for the strength that is born of conflict with hard conditions.

VIII

POSSIBLE CAUSES OF ACCELERATION IN THE FUTURE

Socialism is protean in the forms it takes, but in whatever shape it may manifest itself we may feel sure that consciously or unconsciously it aims at putting a stop to the struggle for existence. It must, therefore, be ruinous to the race though in its milder forms it may conceivably benefit the generation which introduces it by mitigating the strain of competition. Mr Benjamin Kidd has explained the nature of socialism with admirable clearness. He has shown how evolution has worked in regions which writers on the subject had hitherto left almost untouched. Human evolution was left in obscurity, avoided by nearly all biologists since Darwin till Mr Kidd's book [1] appeared. Thoroughly alive to the necessity of Natural Selection if the race is to be vigorous, he strongly condemns socialism as an attempt to put a stop to its working. But after taking up this position he proceeds to advocate "equality of opportunity" for all, not seeing, apparently, that this equality of opportunity could only be brought about by socialistic means, or, even if it could be realised by some other method, that it would be in itself pernicious to the race. Socialism

No part of life is more important than the first years of it. If all children are to have equal opportunities they must be taken as soon as possible after birth and brought up by the State—a most deplorable fate for them all. But if Mr Kidd means only that education is to be open to all, made so cheap that a poor man's son may get instruction sufficient to fit him for any post, yet it must be remembered that education goes on largely at home and that free schooling, the doing away with the heavy expenses that debar the poor from many professions, is by no means an equalising of opportunities. Apart from the question of education, a man's strength depends much on the way his

[1] *Social Evolution.*

parents have fed him during infancy and, going further back, on the conditions under which he developed before birth. Equality of opportunity, then, must obviously come, if ever it does come, as part of a thorough-going socialistic system, which must equalise the circumstances of the parents no less than those of the children. Such a system is utterly chimerical. But there may be some approximation to it and, therefore, it is important to point out its pernicious nature. It is a truism that socialism tends to destroy the stimulus to exertion and so stops human progress. On this point there is no need to dwell. To see its consequences fully, we must recall what I have maintained above, viz., that the superabundant energy that is required, especially in the leaders of the nation, must be derived ultimately from the physically harder lower classes. Were it possible, through a great increase in the national wealth, to make life equally easy for all children, to give them all a good start in life, feed them with the best of food, clothe them and house them well and give them all a splendid education, then, no doubt, among the myriads of competitors thus brought into the field, many first-rate men would be found. But for the sake of this brilliant outburst we should have done much to exhaust our great reserve of potential vigour, the hardy lower stratum of society, from which alone the upper stratum that is perpetually tending to become used up and effete, can be regenerated. We should have made our nation like the ancient states, which, based as they were on slavery, were without the fertile source of renewed vigour with which the freedom of all classes has endowed the modern state.

The declining birth-rate

The keenness of competition and the bitterness of failure make many men turn to socialism as a remedy. And if we study the tendency of the annual birth-rate it is impossible to doubt that the difficulty of over-population and the consequent stress of competition is being dealt with in another way. From 1847 to 1876 there is an upward tendency. The figures mount by slow steps with occasional slight relapses from 31·5 births to 1000 persons living in the first year of the period to 36·3 in the last. After that the tendency was reversed and the rate

has steadily declined from 36·3 in 1876 to 29·7 in 1896. In 1877 there was a decline in the marriage-rate, and since then there has been but little recovery. For the period 1867-1876 the average annual rate was 16·65 to 1000 persons living, from 1877-1886 only 15·01. Since which date there has been a slight rise, the average from 1887-1896 being 15·09. Thus the reduced birth-rate is very largely due to the reduced marriage-rate, but it is known that, in addition to this, a cause of decline that has long been at work in France has begun to tell in England also, viz., artificial restriction.[1] Now this has, I believe, an important bearing on the question now under discussion, the tendency of civilised man to degenerate physically. The reader will remember that Professor Karl Pearson has shown that twenty-five per cent. of the marriages produce quite fifty per cent. of the next generation. It is beyond dispute that the fertility of the mothers of large families is correlated with general vigour. In the absence of restrictions, therefore, the great majority of the next generation will spring from these vigorous mothers. But supposing that, for the reason stated, no family exceeded four, then a far smaller proportion of the next generation would be born from mothers of great fertility and correlated vigour. Thus a decline in the birth-rate even though due to artificial causes must lead to a decline in the vigour of the race.

Further than this, if fertility is hereditary (and there is reason to believe that it is [2]), the artificial limitation of the number

[1] The report of the Registrar-General for 1898 leaves little doubt on the subject, for the last three years for which the figures are published (1896-1898) show a continuous rise in the marriage-rate and yet the birth-rate has continued to decline.

[2] See Prof. Karl Pearson's paper Proc. Royal Society, vol. lxiv. p. 163. He decides that fertility is undoubtedly inherited from mother to daughter, but that this is largely screened by other factors. The more stringently these factors are removed, "the more the regression of daughter on mother moves up towards the value required by the law of ancestral heredity."

Mr Howard Collins in a letter in *Nature*, Nov. 3rd, 1898, brought to light some very remarkable facts that seemed to show that in the most wealthy classes fertility was quite independent of heredity. However, evidence drawn from so artificial a stratum is necessarily rather untrustworthy, and we may accept Prof. Karl Pearson's decision. Heredity is a factor but it is not the only one. Environment and age at marriage count for a great deal.

of births would in process of time lead to a physiological limitation, since the fertility of a race is maintained only through the fact that in each generation the offspring of prolific parents outnumber the offspring of the less prolific. When this is prevented, the race must lose its power of rapid multiplication. This necessarily follows if we assume that fertility is hereditary. The matter will be perfectly clear if we take an extreme case. Let us imagine six married pairs, three of which under natural conditions would have each two children, while the other three would each have ten. In this case five-sixths of the younger generation would be the offspring of fertile mothers. But if through artificial restriction the number of children is limited to two, then only half of the next generation will be sprung from a fertile stock. And thus a physiological limitation will follow in the wake of an artificial one.

IX

POSSIBLE MEANS OF CHECKING DEGENERATION

Improvement of conditions not a real remedy

In the last resort there seems to be no means of improving a race except selection. The improvement of the environment so that the component individuals may attain their full development is a different matter. And if we wish to think clearly on the subject, it is important to keep the two quite distinct. Practically a great deal remains to be done that would tend towards what would in popular language count as race improvement. In particular an enormous gain in vigour would result from an improvement in the health of mothers. During pregnancy the mother is the child's entire environment. It is only through her that he comes into contact with the world. He may be described as parasitic upon her, receiving, as he does, food that has already been assimilated. Even respiration is done for him, since he is nourished with blood that has already been oxidised. It follows, then, that the health of the mother is of supreme importance during pregnancy. During this time the child may gain or fail to

gain health, or, possibly, may even be infected with disease. In these cases we often speak vaguely of inheritance. But, to speak more correctly, the mother is an external condition. And the child has already begun to feel the powerful influence of the environment on his individual life. For clearness of thought, then, we must distinguish between race improvement and the improvement of the environment for the individual at the very earliest stage. Nevertheless, taking a practical view, it is clear that a great deal may still be done for the nation by the bettering of the environment, and in particular by the bettering of the health of mothers. There is still a very considerable fund of potential strength in our poorer classes which remains to be thus exploited. The conditions of life, especially in our big towns, are hard, and by improving them we should confer upon those classes who are degraded by squalor that superabundant vitality, that easy superiority to environment that is the antecedent condition of energy and enterprise. In one way the environment is easy enough. There are hospitals and medical attendance everywhere to be had. But this does much to aggravate the evil. If you surround people's lives with squalor and hunger, and then, directly they are likely to succumb to the strain, put them in a comparative paradise, a region of ease, comfort, cleanliness, and good food, they may recover, but they will go back to an unequal struggle with their normal circumstances. Mr Francis Galton says that the poor classes of London look to him like people for whom the conditions of life are too hard. The explanation surely is that the conditions are not allowed to work freely. Charity steps in and prolongs the misery. What is wanted is an improvement in the *normal conditions of life*, better housing, better food, and, more still, in the moral atmosphere, so that there may not be, after recovery from illness, a return to squalor and unwholesomeness.

But though everyone must hope that the progress already made towards rendering the lives of the poor in big towns more healthy may continue, yet it is impossible to see in that a preventive of degeneration. We should be using up our capital of race-vitality, not increasing it. We should be merely making

the environment less harsh, though by causing it to act through the mother indirectly upon the child we might seem to have heredity on our side and to have settled the whole problem of race. The immigration of men of races as yet less weakened by civilisation operates in the right direction and can do only good, provided that (1) they come of Aryan stock; (2) that the numbers admitted are not too large to allow of easy and rapid assimilation. To introduce Chinamen or men of other inferior breeds, as hewers of wood and drawers of water, while the higher race expect to be all ladies and gentlemen, would be to undermine the national strength. The ancient states, resting on a basis of slavery, grew effete because they lacked the proper substratum—a large free population, of the same blood as the upper classes and having the right of intermarriage with them—which is the primary condition of durability. When a nation consists of an aristocracy *et præterea nihil* its end is not far off.

Immigration of men of hardier races

But the gradual admission of hardier foreign races is but a very slight mitigation of the evil. It remains to be considered whether there is any means of bringing about race-improvement in the strict sense of the term. This can only be effected by selection, by elimination of the weak, and it is contrary to what is best in man to refrain from using his science for the benefit of all the children that are born into the world whether strong or weak. We cannot have a Mount Taygetus attached to every town. On the contrary, that very unspartan institution the "parish incubator" is likely to become common. But if there is to be any real check to degeneration it must come from religion and moral principle. They have largely guided evolution in the past and they may in the future take upon them new work. But it will be better to postpone this question until moral and intellectual evolution have been discussed.[1]

The question postponed

[1] See chapter xii.

Chapter X

MORAL EVOLUTION

I

RUDIMENTARY MORAL GOODNESS

IT will be sufficient to recall very briefly what has been said on this subject. Where there is no parental affection and no nursing of the young, where the eggs are left to hatch as they may, and the young have to fight their own battle from the moment of birth, there we find none of the higher forms of life. Among amphibians there is some first beginning of a care for the eggs. But it is only among the warm-blooded animals that we find anything worthy of the name of parental affection. Elsewhere Natural Selection falls with pitiless directness upon the young, and the upward progress of evolution is checked. In many species, when once maturity has been attained, there is no mutual help. It is each individual for himself. But many animals live in communities and combine against all assailants. Many birds are sociable and make common cause against birds of prey. Monkeys, cattle, deer, antelopes, are examples of sociability. This is so marked in many cases, that it has led some writers to underrate the importance of Natural Selection. **Birds and mamals: parental affection and sociability**

The tendencies just pointed out, however, do not reduce the power of Natural Selection, though they alter the method of its working. It may be all the more efficient when it acts indirectly; in other words, when it acts on a family or community, and not on an individual. In either case it retains the power of pronouncing its verdict. Tiger and tigress tend their young with the utmost affection. But suddenly the affection comes to an end, and the young tigers have to face the world alone. The stress of Natural Selection is as severe as ever. But the sheltered time **Natural Selection becomes not less but more efficient**

of immaturity has allowed the development of congenital points of superiority and inferiority till they are salient, and help to decide the great question—survival or non-survival—and thus there is less indiscriminate destruction, and more selection for merit. Natural Selection, by acting for a time on the offspring, mainly through the parents, becomes more efficient. Communities of animals are no less subject to it. There is no tending of the sick; indeed those which are wounded or ill are often cruelly bullied, though Mr Hudson tells us that among cattle the lords of the herd are above taking part in the bullying: it is left to the lower and meaner characters. Nevertheless it takes place. In fact, nowhere in wild nature is there to be found, if we except the affection of parents for their young, any sympathy with weakness. The associations are combinations among the strong for mutual defence or sometimes for combined attack. If any member of the association cannot contribute his quota, he is allowed to perish, or is even ejected.

So much for this side of the picture. We must not entirely lose sight of the other. Though, among animals lower than man, even the affection of parents for their offspring is kept by Natural Selection within very strict bounds, yet we cannot help recognising at this stage in evolution some rudiment of altruistic spirit, some rudiment of goodness. Among men there is much more freedom to deviate from the line of conduct that the welfare of the race demands, and it is, in a large degree, this freedom which makes human evolution so different from that of other species.

II

THE PLACE OF MORALITY AND RELIGION

Science and altruism weaken the action of Natural Selection upon individuals

Among men the spirit of mutual help does not work within bounds strictly defined by Natural Selection. The young are not flung out into the world with the suddenness that a young pigeon is thrown upon his own resources. The sick and the helpless, to whatever cause their helplessness is due, are fed

and tended. A spirit of altruism characterises society more and more as civilisation advances. It shows itself very conspicuously even in legislation, and in England if the worthless and the idle die of starvation, it is not the fault of our laws. Thus the mutual helpfulness on which depended the strength of the tribe or nation in war has broken through the limits set by expediency. There is no thought in pure philanthropy of what is good for the nation. The relief of distress comes to be commonly regarded as good and right in itself whatever the ultimate consequences may be. It is equally true that a nation that has very little of the altruistic spirit cannot be strong. If the upper classes selfishly allow the poor to live in squalor, degradation and practical slavery, then the whole nation will, no doubt, in time suffer for the sins of its wealthy citizens; all this is undeniable, but we are considering at present the ill, not the good, done by altruism. There is no doubt that it tends to keep alive vicious tendencies. The drunkard is not left out in the cold to die where he has fallen, and when at length he succumbs, his children are not left to starve.

Medical science works in the same direction. Among barbarians, it is true, the medicine man may have helped to despatch invalids. And even in our grandfathers' or fathers' time doctors with their copious draughts may sometimes have assisted Natural Selection. But what a sick man mainly requires is to lie in bed and to have food brought to him, instead of having to go out beneath the fury of the sun, in the pinching cold or the drenching rain to get food for himself. Now this has been possible for the sick for many ages past even among half civilised peoples. And the fact that rest and shelter are obtainable during sickness make a man's position utterly different from that of one of the lower animals. Even before the days of medical science properly so called, he could afford to reduce himself to an invalid state for a time.

Altruism and science work together. A man is not allowed to perish from the effects of his own folly, for science, at the command of altruism, steps in and saves him. When illness is caused by self-indulgence, science is ready to mitigate the con-

sequences, whereas Natural Selection, if allowed to work freely, would soon eliminate all who have a propensity to excess. The children of the ne'er-do-weel must not suffer from the folly of their father, and thus, natural affection, the fundamental virtue that guided evolution in early stages, is struck at. And these are not the only evils that human cleverness helps to foster; it brings about others of another class, and these without the assistance of tender-hearted altruism. It enables a man to devise ways of cheating his fellow-tribesmen or fellow-citizens that may very possibly remain undiscovered. Hence the growth of the anti-social sins, such as stealing and fraud of all kinds.

Benevolence and cleverness have combined to foster self-indulgence and failure of natural affection, while cleverness, in defiance of the general spirit of benevolence, has devised, and is devising, a number of anti-social practices. Thus human society might seem to be travelling along the road to ruin. Among the lower animals Natural Selection never lifts its guiding hand. To savages it does not give a very free rein. But every advance in civilisation is a blow dealt at Natural Selection, at any rate, at its direct incidence. Vice still suffers, no doubt, but very often not to the extent of elimination; wealth, science, altruism, befriend it. Altruism takes children that have been left by their parents in the gutter, and brings them up in institutions, thus tending to breed a race deficient in natural affection. And, lastly, cleverness finds under present conditions a better field than ever for anti-social conduct of all kinds.

To all these tendencies there is a powerful check. There is the struggle between tribe and tribe, which in early times must have been constant. The tribe in which vice and dishonesty throve would be defeated by another tribe which had the corresponding virtues. But this is only saying that a principle hitherto undeveloped had come in to fill the great blank left by the retreat of Natural Selection. Men even in a very early stage were no longer eliminated inevitably and immediately as a consequence of folly: the children of the worthless survived; social life offered great opportunities to the man who was both selfish and clever

to prey upon his fellows, and Natural Selection could not, in all cases, act *directly* or speedily upon him, but only upon the tribe or nation in whom there were many such individuals.

The nation and the individual: apparent antagonism of interests

Circumstances had arisen in which the citizen or tribesman might do a host of things most damaging to the community, but only mildly or not at all injurious to himself. There had arisen, in fact, a conflict between the interest of the community and what the individual might suppose to be his interest, and, unless through some tendency or influence hitherto not in operation, the individual came to identify his own personal welfare with that of his tribe or nation, then society must die through its own corruption.

Intervention of religion

This seeming conflict of interests was clearly seen by Mr Benjamin Kidd, and very clearly explained in his *Social Evolution*, published in 1894. But though the book was much read, it was apparently, in spite of its clearness, but little understood. The critics laid hold of unimportant defects and trifling side issues, and missed the main argument. I quote a passage which deals with all possible lucidity with the question at present under discussion. "A religion is a form of belief, providing an ultra-rational sanction for that large class of conduct in the individual where his interests and the interests of the social organism are antagonistic, and by which the former are rendered subordinate to the latter in the general interests of the evolution which the race is undergoing."[1]

Religion, in fact, binds society together, fighting against the disintegrating tendency to which we commonly give the name of selfishness, and which enlists the services of reason to justify itself. It is religion that has made it possible for the human race to rise above the mere animal state, and made possible also its advance to the highest levels it has attained. To the seeming antagonism (it can be shown that there is no real antagonism) between the interest of the individual and that of the community, we must trace the evolution of good and evil. Man alone is troubled with conflicting impulses—what he considers his own interest pulling him one way, his duty pulling him in the opposite direction—and it is this which has necessitated the existence of

[1] *Social Evolution*, p. 103.

morality and religion if he was not to supply an instance of retrogressive development. No other animal but man has reached a stage at which virtue, properly so called, is possible. In birds and mammals in general we can recognise only a very rudimentary goodness; for them sin does not exist. Any irregularity of which an individual may be guilty brings on him or her its immediate punishment, or else the offspring perish and the bad stock disappears. The swallow whom instinct does not drive to migrate to the south is killed by our northern winter. If a thrush eats poisonous berries death is the consequence. If a foolish calf gorges itself on green clover, its end is speedy. If a wild bird does not feed her young they perish, so that no breed is formed in which natural affection is lacking, except in a few instances of parasitism of which the cuckoo is the most familiar example. Since punishment falls swiftly on every irregularity, it is difficult to speak of such a thing as sin; it is only an unfavourable variation. Nor can we say that among the lower animals there is any such thing as virtue in the strict sense. There are qualities which claim our admiration. Birds will fight for their young. Maternal affection will put courage into the hearts of the most timid. They will fight, or feign to be wounded and draw the danger upon themselves. Among mammals parental affection is more highly developed: the bird is no doubt out-distanced. Yet even in birds there is undeniably a rudiment of goodness, however unconscious it may be. But nowhere except among mankind do we find anything that can strictly be called virtue. An irregular tendency which in man we should stigmatise as a vice is among animals at once wiped out by Natural Selection, and therefore the animal world is a region of instinctive right impulse. Those whose nature prompts them to conduct that would be injurious to the species do no harm, since they themselves speedily expiate the irregularity, the unfavourable variation, or whatever we may choose to call it. Moreover, there is never such a thing as a struggle between impulses, one of which may, in popular language, be described as selfish and the other as unselfish. The system of Natural Selection gets rid of all half-heartedness. The bird that in the nest-

ing time had "two minds" as to the desirability of devoting her life to the care of her young would not be successful in rearing any. It is only when the edge of Natural Selection is blunted, and the unworthy are allowed to survive, that the apparent antagonism between the interest of the individual and that of the community makes itself felt. With the blunting of Natural Selection definite moral goodness and sin appear in the world, owing to the fact that aberrations under the new conditions are ruinous, not so much to the individual as to the community to which he belongs. Under these circumstances there is consciousness of free will — we all assume it and act upon the assumption, however decisively we may be defeated when we argue for it. Indeed, to assume it is the only working hypothesis. There is freedom to choose between right and wrong. But to discuss free will is altogether beyond the scope of this book.

The old proverb "honesty is the best policy" does not recognise any antagonism of interests. But interpreted, as it usually is, to mean that material prosperity will necessarily result from honest dealing, whereas the knave will be unsuccessful in his attempts to make money because of his knavery, the proverb hardly represents things as they are: fortunes are often accumulated by the aid of very questionable practices. But, of course, there is a sense in which it is to the interest of every individual to be honest. If we start with the assumption, from which no good man would withhold his assent, that nobility of character is the best thing we know of, then the dishonest man forfeits by his dishonesty that which is best worth having. There is, therefore, no antagonism between the true interest of the individual and that of the community. A man of noble character identifies his interest with that of others. Without such identification none of the noblest actions would be possible. When a man is doing a deed heroic enough to deserve the Victoria Cross, however great the risk and pain involved, we cannot doubt that his action brings with it a conscious enjoyment. It is the completeness with which he makes the interest of others his own that gives the motive for the noble action, and that must give rise at the moment to a feeling of satisfaction.

The nobler Hedonism

This truth finds expression in the philosophy of those Hedonists, who see in pleasure the only possible motive for action, but who would maintain that what we call self-sacrifice, really the identification of the interests of the individual with that of others, is the highest pleasure of all. In spite of this there remains the antagonism between the interest of the community and what to an average person among the mass of people that compose it is likely to appear conducive to his or her own welfare.

Morality

Moral principle tells a man that it is not right to follow his own selfish ends, that he must give up his own pleasure and devote his energies to bringing up his family or to civic duties, that he must not be guilty of theft or of fraud, or of any questionable practices. This is the wise counsel which morality and philosophy can give in plenty. But moral philosophy, the exponent of morality, cannot speak with emphasis. She is beautifully didactic, but a poor preacher: an excellent teacher for those who have already learnt most of their lesson. Religion alone can preach. Religion alone can sway the mass of mankind. True, the man of high culture may possibly dispense with it. Science itself may be of the nature of religion, if what Professor Seeley says is true that religion in its elementary state "may be described as habitual and permanent admiration." But for the huge majority of mankind something else is wanted to enforce the laws of morality. And this brings us back to Mr Benjamin Kidd.

Antagonism of religion and reason

He emphasises very strongly his view that religion must be ultra-rational. Reason, he maintains, is a disintegrating force, the destructive operation of which has constantly to be checked by ultra-rational religion. It has been objected that reason does not always work disintegration but sometimes sides with religion and helps to consolidate and cement society. We may grant that this happens not unfrequently, and yet Mr Kidd's contention is true. It is his reason that enables a man to gain wealth by swindling and unsocial conduct of various kinds. It is his reason that enables him to systematise and persist in vicious habits to the injury of the nation to which he belongs, without, in his individual self, paying the penalty. It is his reason that

enables him to gratify his sexual instincts without incurring the associated responsibilities. It is no answer to this indictment to say that the highest philosophy is not hostile to religion, but often becomes its ally. We have to do with the arguments that present themselves to the minds of average men and, but for conscience which is ultra-rational, would sway them towards conduct such as must disintegrate society. It is true that, as evolution proceeds, the tendency to mutiny against social restraints grows weaker. Though vice and dishonesty may often prosper, yet the set of the tide is against them. Though there is no instant elimination for irregularities as among the lower animals, yet the old process is still working: those unfitted for life in civilised communities tend eventually to disappear. The persons who are the parents of the next generation are mainly of a different stamp. They are those in whom conscience and religious principle check the vagaries of reason. Putting the matter in popular language we may say that human cleverness enables selfishness to find endless ways of gratifying itself without paying any immediate penalty beyond that of degradation of character, and that religion alone can check the ruinous tendency. Thus religion binds man with laws from which he can only with difficulty free himself and so is the cement of society. Reason is the disintegrator, wrong-headed, short-sighted reason it must be owned, but still reason, the crude philosophy of the man who knows how to gratify his appetites, but knows little beyond this, and who makes what little power of ratiocination he has subserve his appetites. This is not a very noble part for human reason, the much belauded, to play. But she sometimes finds a nobler rôle. Religion often tends to become an over-elaborated framework of doctrine and ceremony, obscuring what is really essential. In such cases reason, armed with the facts of experience, may interfere—has sometimes interfered—and allying herself with all that is true and essential in religion has waged war successfully against what is unessential. To this we may attribute the reform of the taboo system as well as more recent reforms with the history of which the world is familiar.

Recapitulation

It will be well now briefly once more to trace the main outline of the argument. The blunting of the edge of Natural Selection among men, its failure to eliminate individuals for irregularities that are injurious to the tribe or nation has led to a seeming antagonism of interests. The individual, making for an objective that commends itself to him, adopts a line of conduct that tends towards the disintegration of the community and Natural Selection does not step in promptly to deal with him and his ruinous philosophy. Morality and religion then intervene to fill the blank left by Natural Selection.

It is important to notice that while combating vice they have not as yet protested against the propagation of weakness, the possibility of which, no less than the possibility of vicious habits, is traceable to the slackening of Natural Selection.

Before going further I will point out that much of what I have said, though deducible from Mr Benjamin Kidd's formula, does not actually find expression in it. He was the first to explain the connection between religion and the apparently conflicting interests of the individual and the community. Following out this idea I have shown that good and evil can be traced to that stage in evolution when Natural Selection ceased with unerring certainty to punish personal vagaries, and in consequence the antagonism manifested itself.

Evolution and origin not the same thing

To some people it may seem that I have been finding rather a humble origin for great things, for goodness and evil. But when we have explained the evolution of goodness we have not explained its *origin* in any true sense. I have merely shown that the conditions of human evolution rendered its existence essential and that under these conditions it has shown itself as a favourable variation and has gone on developing, the races who had much of it, having an advantage over those who had little. The origin of goodness is another thing altogether. Without travelling beyond the proper scope of this book, I may say that as evolutionists we are bound to assume that all the qualities that we find in any product of evolution may be considered to belong equally to the force that existed prior to evolution. To apply this to the matter in hand, if goodness has

appeared in the world only in evolution's latest stage, we may nevertheless infer its existence before life began upon the earth. This inference is as sound and reasonable as it would be if man had been created with all his moral qualities at their highest. The Darwinian believes that no new power or faculty has been introduced from without, since the simplest forms of life began the course of evolution that was to end in the most complex and highest. It is evident, then, that on this hypothesis goodness existed potentially from the beginning, only waiting for the required circumstances to develop it.

But if from the existence of goodness we derive our faith in a good that was before evolution began its course, may we not equally from the existence of evil infer a pre-existent evil activity? Let us look at the facts. First, we must not forget that rudimentary, unconscious goodness (the affection of parents for their offspring as we find it in birds and mammals, their associations, too, for mutual defence) made possible the evolution of all the higher forms of life from the lower cold-blooded forms. Lower in the scale than man we see nothing that we can call wickedness, and for the obvious reason that all aberrations are stamped out with a speed that steals them from our sight. Deviation from the right course is not tolerated by Natural Selection. We have, however, some instances in which the members of a community help on the working of Natural Selection in a way that has always appeared to civilised man as utterly cruel. Cattle push and illtreat a sickly member of the herd, as if to hasten it out of existence. The worker bees, if their hive has a fertile queen, set upon the unfortunate drones in July or August and massacre the whole number. But neither of the cattle nor of the bees can we say that they are, in any possible sense of the word, wicked. They are cruel, but they are not cruel for their own personal ends. They are driven on by a blind instinct to do what is in the long run good for the herd or the hive. A community in which all are vigorous and do something for the common good is better off than one with weak or idle members. If we see no great nobility of virtue in the devotion of a bird to her young since she is driven by an

irresistible instinct and is unable even to see the selfish alternative, we must not find any great barbarity in the cruelty of bees or of cattle.

Bees: their limitations

The social life of bees is so extraordinary and bears so upon our present subject that I shall pause a moment to consider it. Every worker member of the community labours with the utmost energy for the common weal, shortening her life by unceasing toil. Social life is brought to the greatest perfection that without the aid of conscious sense of duty and moral principle we can imagine attainable. All this perfection must be due to stringent Natural Selection, though the method of its working is hard to detect. I suggest a way in which it may act: I can see no other. Though none of the work of collecting honey, building cells and feeding the young is done by either parent, yet all the faculties and powers of the workers must be present either in one or the other, or in both. Suppose that they are latent in the drone. Now, it is well established that the queen never unites with the drone in the hive but always on the wing, and it is probable that by this means one of the most vigorous drones from an enormous number is selected. If with vigour in the drone are correlated the qualities that go to make a good worker, then we can understand how it is that hive bees seem always to be perfect models of energy and skill.

We must now see how this bears on our argument. Stringent natural selection has produced a wonderful community in which there is a more ardent spirit of co-operation than among any other animals lower in the scale than man. But bees and other social insects are its culminating achievement, not a dim suggestion of great possibilities some day to become realities. We see in their social life the high water-mark attainable where Natural Selection works unaided. And if the bees themselves give point to the system by their own cruelty, we may say that, though they are thus doing the best for the hive, yet that the use of such means has cut them off from all possibility of advance to a still higher social state.

For man a further advance has been possible because he has left such methods behind. If human altruism had been so

defective, so capable of cold-blooded calculation that it admitted of the elimination of all who had become useless to the tribe or nation, evolution would have been checked at a very early stage.

In the cruelty of hive bees, then, we can hardly see an exception to the rule that an advance to the higher stages of evolution has been brought about by a tendency to prevent the direct incidence of Natural Selection, not to supplant its pitiless action. Rather we must see in it the highest development of a lower system that evolution was to drop in its upward course. Among men evolution fosters a spirit that is intolerant of cruelty. Folly, except in extreme cases, is reasoned with and preached at, not ruthlessly abolished. And naturally, since to treat it so would be to violate the principles that have made the higher evolution possible.

The tendency of evolution among men

But, though shielded by altruistic principles, anti-social tendencies do not go unchecked. The set of evolution is against them: the drones among men are in the long run somehow eliminated without any resort to degrading methods. The flow of the tide is still more apparent if we consider competing communities rather than individuals. It is through virtue—mutual help, loyalty, honesty—that nations thrive.

We see then, that all evolution above the level of the cold-blooded animals has proceeded by means of the elimination of all that had no impulse except to fight and struggle for their own individual selves. At a higher stage, among men, it has advanced partly through the elimination of those whose character was anti-social, but very largely through the repression of anti-social tendencies by religion. If such are the means by which the higher results have been attained, if evil is being perpetually eliminated or subjugated, then we cannot look upon it as a primary principle. Whatever small or temporary victories it has won, they have led only to eventual defeat.

Two possible misunderstandings

I wish now to guard against a probable misunderstanding. Much has been said about the apparent antagonism between the interest of the individual and that of the community, and the function of religion in making a man sink what he deems his own

interest for the common welfare. But it must not be imagined that this argument is used by religion or even by morality. Religion speaks of certain things as *wrong*, as *bad in themselves*, and of certain other things as good, quite apart from ulterior consequences. An ideal of right is thus set up, to be aimed at without thought of gain personal or national. But this ideal will be found to be identical with what in the long run is the interest of the nation. Conscience, it has been said, is the tribal self. The good man drops his own self and identifies himself, unconsciously, with the community.

Before concluding this division of the subject, I shall try to meet another objection that is likely to be raised. If the office of religion is to save the tribe or nation from disintegration, if that is its sole function, why does it appear in so sublime a form? If all that is required is the production of honesty sufficient to save the nation from defeat and extermination, is not the phenomenon altogether too great and noble to result from such a requirement? But mere business honesty when spread over the mass or even a large percentage of a people is a very grand thing. It is no use trying to belittle it. This, however, cannot exist unless something much higher exists in the leaders of the nation, those who are to it

"'The glass of fashion and the mould of form."

No nation in the matter of honesty forms a flat elevated plateau. There must be pre-eminent peaks or else the general level will be miserably low. And, therefore, in the struggle between tribe and tribe, victory would often lie with that one which had among its members some spirit of the highest order who could raise the general tone of morality among his fellow tribesmen. Religion in its highest manifestation is seldom above what is required to lift the inert mass to the level that the actual needs of a nation demand.

III

THE CONNECTION OF RELIGION WITH MORALITY

If we hold that a belief in spiritual beings is the germ from which religion has developed, then there is no existing tribe that is utterly non-religious. To such rudimentary religion the term animism is often applied. To primitive man every living creature and even all lifeless objects with which he came in contact were animated with a life and will like his own. Dreams suggested this view of the world. In sleep he was elsewhere: when he awoke he could remember where he had been and what adventures he had had. And yet his friends could assure him that he had never moved from his hut. His body, therefore, was tenanted by a spiritual being. And why should not all things around him have similar tenants? Primitive Religion

Animism had two main developments, the belief that man had a soul which survived him, and the belief that there were spiritual beings which had power to control the events of the material world. A full account of the subject will be found in Tylor's *Primitive Culture* to which I refer the reader. Here I wish, if possible, to give some idea of the way in which it came about that religion brought within its jurisdiction all questions of morality. I attempt this because of the great interest of the subject, not because the importance of religion in human evolution cannot be understood without a knowledge of the relation of religion to morality in primitive times. In whatever way it may have arisen the fact of this relation in civilised communities is plain enough. Nevertheless it will lend force to my argument if it can be shown that the connection between the two began at a very early period. Mr Jevons' *Introduction to the History of Religion* throws much light upon the subject, and cannot fail to arouse the interest of all who read it. From him I borrow a number of facts; some of his inferences I am unable to accept.

We can hardly doubt that morality owes its origin very largely to the system of Taboo. This system is universal among savages; it extends like a network over the whole of Taboo

their life. It is not everywhere called by the Polynesian name Taboo, but the institution is present none the less. The word means "strongly marked" and is applied to anything that is dangerous to come in contact with: things holy are as taboo as things unclean. There are three classes of objects which are inherently taboo, blood, babies, and corpses. And this suggests the origin of the institution: anything that has to do with the mystery of life or death is *ex officio*, so to speak, taboo.[1] Holy persons, chiefs or priests, have this character in a marked degree: they are dangerous to have to do with. And taboo is transmissible. Any person, who has touched or seen or been seen by any person who is taboo, is infected. It is the same with things. What is thus infected, however, is not strictly speaking taboo, it is only tabooed. But for all practical purposes this is the same.

"Perhaps the most remarkable instance of the contagion of taboo is to be found in the fact that it is capable of infecting not only things but actions, and even time itself. Thus among the Basutos, on the day of a chief's decease, work is tabooed: the corpse defiles not only those who come in contact with it, but all work done on the fatal day."[2] A few more examples of the contagiousness of taboo. A new-born child infects its mother. In West Africa she remains unclean for seven days, on the Loango coast for six months. "Holy persons such as the Selli and tabooed persons, *e.g.* candidates prepared for initiation in the Eleusinia, may not wash, for fear, probably, lest the sanctity should be communicated by the water to other persons or things, in the same way as the impurity of the murderer in Greece might be conveyed by the offerings used in his purification."[3] "The infection of holiness produces exactly the same results as the pollution of uncleanness, that is to say, it renders the thing touched taboo and, therefore, unusable."[4]

In Tahiti "if a chief's foot touches the earth, the spot which it touches becomes taboo thenceforth, and none may approach it —chiefs are, therefore, carried in Tahiti when they go out. If

[1] Jevons, *Introduction to the History of Religion*, p. 86.
[2] *Loc. cit.* p. 65. [3] *Loc. cit.* p. 78. [4] *Loc. cit.* p. 62.

he enters a house it is from that moment taboo: no one else may go into it ever after. No one may touch him or eat or drink out of a vessel which he has touched."[1] In Samoa "Tupai was the name of the high priest and prophet. He was greatly dreaded. His very look was poison. If he looked at a cocoa-nut tree, it died, and if he glanced at a bread-fruit tree it also withered away."[2] "The king of Loango may not for the same reason see a river or tree, and he has to make many long detours in consequence when he goes visiting. In some places girls, when taboo, have an equally poisonous glance and are made to wear broad-brimmed hats in order that they may not infect the sun."[3]

I give these few examples to show the terrible contagiousness of taboo; at this rate the whole earth would soon be infected, the sun itself is in danger.

So far as we have proceeded at present it must be owned that taboo does not appear to be a very valuable social institution. Yet it had a great deal to do with the building up of society. In Mayumbe a woman became taboo when she married; it was death to touch her: and "elsewhere on the Loango coast married women are so taboo that things must not be handed directly to them by a man, but must be put down on the ground for them to pick up."[4] "As for property generally, in Polynesia the owner protects himself in possession by tabooing it; where fishing is conducted co-operatively, the catch is tabooed until divided; when a diamond mine was supposed to have been found near Honolulu, King Tamehameha at once tabooed it, in order to appropriate it exclusively to himself; and European ship-masters who did not care for native visitors got their vessels tabooed by a native chief."[5] Taboo now appears as the defender of the institution of marriage and of the rights of private property! How the common-sense crops up in what seems a mass of outrageous nonsense! The catch of fish is tabooed *until it is divided*! In spite of all its absurdities we may look upon it

[1] Jevons, *Introduction to the History of Religion*, p. 62.
[2] *Loc. cit.* p. 60, quoted from Turner, *Samoa*, p. 23.
[3] *Loc. cit.* p. 60.
[4] *Loc. cit.* p. 71.
[5] *Loc. cit.* p. 72.

as strengthening the feeling of social obligatio[illegible] broke taboo was committing an offence agai[illegible] since he might transfer the taboo to others. Moreover, it was difficult or impossible (it was believed), for the guilty man [illegible] escape detection. He would be punished in some signal [illegible] As to what the consequences of the breach of taboo are, [illegible] usually seem to give very vague answers. But [illegible] often loom bigger because they are vague. [illegible] however, of the awful consequences to the taboo breaker [illegible] record. "It happened that a New Zealand chief of high rank and great sanctity had left the remains of his dinner by the wayside. A slave, a stout hungry fellow, coming up after the chief had gone, saw the unfinished dinner and ate it up without asking questions. Hardly had he finished when he was informed by a horror-stricken spectator that the food of which he had eaten, was the chief's. . . . No sooner did he hear the fatal news than he was seized by the most extraordinary convulsions and cramp in the stomach which never ceased till he died about sundown the next day."[1] "Contact with the Mikado's clothes or drinking vessels was avoided, not from fear of contracting any of his qualities, but because the clothes would cause swellings and pain all over the body, and the vessels would burn up the throat."[2] Sometimes, however, the breaker of taboo would be put to death or all his property seized by his neighbours.

Two things are now clear: (1) Taboo helps to lay the foundation of society; (2) the awe in which it is held is so great that those who violate it are sometimes terribly punished.

The nature of taboo has been the subject of much discussion. Is it religious? Mr Jevons says definitely Not. He argues that it is very often difficult to trace the connection between a particular taboo and a god. But when the transmissibility of taboo is remembered the objection seems untenable. The things which are inherently taboo are blood, babies and corpses (all suggesting, as he says, the mystery of life and

[1] *Introduction to the History of Religion*, p. 83, quoted from Frazer, *Golden Bough*, p. 168.

[2] *Loc. cit.* p. 84.

to me no explanation. His view is that the sentiment among savages which forbids the doing of certain things is "primitive.' This means, I suppose, that we have reached an ultimate point in our investigations and that we must not try to get behind taboo: it is the nature of the savage to believe in it and we must accept it without inquiring into its origin. To most men this will seem an unsatisfying explanation, to the Darwinian it is an impossible one. Taboo cannot have existed for the ancestors of man before they reached the human stage. Nor can I agree with Mr Jevons as to the process by which taboo was purified, so that the reasonable taboos remained while the irrational ones passed away. He traces this to the taking up of taboo into religion. But his separation of the religious philosophy of the savage from his taboo philosophy is an entirely arbitrary one: how, then, should one reform the other? And if we are told that religious reformers abolished absurd restrictions and retained those which were reasonable, how did these reformers discover which were reasonable and which were not? Now, there is only one way of testing the soundness of one's philosophy, and that is by applying to it the touch-stone of actual experience. Taboo being almost ubiquitous, must have been perpetually broken inadvertently. A man might find that he had broken it six weeks ago and had been ever since no whit the worse. Hence doubts may have arisen in his mind. He may have reflected upon the subject and obtained further evidence by accident or by actual experiment. As the result

of reflection, observation and experiment, he would be able to discriminate between taboo and taboo. All that seemed real and genuine he might naturally trace to the spirits that were present everywhere, and the result might well be that he would, with full conviction, take upon him the character of a religious reformer. Religion might then assume a higher form, giving its sanction only to those taboos which tended to the good of society. This is not a reform of taboo by religion, but a reform of religion (of which the taboo system was part) owing to a mutiny of common sense and experience against the tangled accretion of absurdities that were strangling social life. But doubtless the reformer said little or nothing about practical experience. He said that some taboos were right and others were wrong. He himself may have regarded the injurious consequences of some taboo restrictions as due not so much to their foolish nature as to the disfavour of a god. Nevertheless it must have been common sense using the test of experience that told him which of all the taboos deserved to survive. How could it have been otherwise when they appeared in ever multiplying swarms till it seemed likely that the contagion would infect the whole world? In fact the transmissibility of taboo must necessarily have made its yoke so galling that even a sluggish people, most loth to reform itself, might well be driven to make an effort to fling it off. But practical philosophy had other means at hand with which to undermine taboo. Intercourse between tribe and tribe must have brought to light many unrealities: what was taboo in one was innocent and harmless in another: things which one tribe shunned with awe and horror, the other handled fearlessly and with impunity. The bladder must thus eventually get pricked.

To sum up then, we find in the taboo system, which is essentially religious, evidence that morality rests on a religious foundation. The reform of taboo, where it has taken place, we trace to a revolt of common sense against the numberless accretions that made it not only an absurdity but a curse to the peoples among whom it prevailed.[1]

[1] On Taboo, see also the article in the Encyclopædia Britannica on the subject.

Retribution in a future life

If the spirit could journey far away from the body during sleep, why should it not continue to exist after the death of the body? This we may imagine to be the argument which savage peoples have dimly formulated to themselves. There seems to be very generally a belief in a future life, but the doctrine of mere continuance is that which we find among the most primitive. A man is not rewarded or punished in the after-world for his good or bad deeds, but he lives on there as he has lived here. "The shade of the Algonquin hunter hunts souls of beaver and elk, walking on the souls of his snow-shoes over the soul of the snow."[1] "The Norseman's ideal is sketched in the few broad touches which show him in Walhalla, where he and the other warriors without number ride forth arrayed each morning and hew each other on Odin's plain, till the slain have been 'chosen' as in earthly battle, and meal-tide comes, and slayers and slain mount and ride home to feast on the everlasting boar, and drink mead and ale with the Aesir."[2] Some very serious defects of this world are evidently corrected in Walhalla, but it is still only continuance, a glorified continuance. Then comes a doctrine which bridges the gulf between the continuance theory and the retribution theory. A man's position in the next world results from his position in this. The great here are great there and *vice versa*. But directly there is differentiation, then the doctrine of retribution must of necessity follow. For it cannot fail to be noticed, when men begin to think, that prosperity in this world is not fairly allotted. While still maintaining, therefore, the old assumption that a man's position in the next world depended on what he had been in this, they came to see that "what he had been" was a question of character, not of wealth, titles and power. Merit or demerit, therefore, decided his fate. This is the doctrine of retribution that so solemnly proclaims to men the consequences of wickedness. Though this view is not a primitive one, yet many races arrived at it and it is found among some who have advanced but a very little way in civilisation. The Choctaw souls journey "far westward to where the long

[1] Tylor: *Primitive Culture*, vol. ii. p. 75. [2] *Loc. cit.* vol. ii. p. 77.

slippery barkless pine-log, stretching from hill to hill, bridges over the deep and dreadful river; the good pass safely to a beauteous Indian paradise, the wicked fall into the abyss of waters and go to the dark hungry wretched land where they are henceforth to dwell."[1] Of all the higher religions the doctrine of retribution forms an essential part.

What influence has it had upon life?

George Eliot thought, very little. Let us leave the most modern type of man out of the question and consider the barbarian or the half-civilised human being. To him the doctrine of retribution was the natural corollary of the proposition that wickedness was wicked, and had he given up the corollary he would have been denying the truth of the proposition. For he had come to believe that a man's position in the future life was in accordance with his real worth in this. If, therefore, he thought of bad things as bad, he must inevitably think of them as being punished in the next world, and thus we cannot dissociate his reprobation of wickedness from his doctrine of its punishment.

Enough has now been said to make it clear that morality has always rested on a religious basis.

IV

HISTORY AND RELIGION

The moral of history

Not all readers of history find the same moral in it. Some maintain that its teaching is that victory is ever to the strong, others that right triumphs in the end. I think we may at any rate say that injustice reduces the strength of the strong. Those who see in history nothing but the oppression of the weak by the mighty quote such examples as the repeated partition of Poland, the Spanish tyranny in the Netherlands, the harsh government of Ireland by England. But in every case where the oppressed are of a vigorous race they are a thorn in the

[1] *Loc. cit.* vol. ii. p. 94.

side of their oppressors. No one can say that the possession of the Netherlands added strength to the Spanish empire. Nor has England gained by her ill-treatment of Ireland. She has discovered, though the discovery has long been delayed, that justice in some form or other is the only means of soothing the discontent that makes dominant nations vulnerable. No doubt, an unprovoked incursion into the territory of a free people may be for the time successful. It is beyond doubt that the people of the United States if they were unanimously so disposed could raise an army that could march through Canada and overpower all resistance. But Canada, though thus defeated, would be impossible to hold as a conquered province. I am quite aware that things were different in the earliest stages of human development. A victorious tribe would literally annihilate the conquered. The Khalifa and his Baggaras have recently given us examples of this primitive method. But the sympathy and fellowship that bound members of a primitive tribe together have in civilised lands extended into a limited goodwill to all human beings. So that the ancient method of extermination which made the triumph of absolute injustice possible has passed out of use, except in some regions as yet unpenetrated by civilisation. It would be possible for England to exterminate the Boers. But it would be nothing short of ruinous to do so. In fact, ever since man's humanity has been so far developed as to revolt at wholesale slaughter, the conquest of a vigorous people has been fraught with evil for the conquerors, except where, as in Canada, it has been followed by the establishment of an equitable system of government.

When the conquered submit with patience to a foreign sway, as the people of many of her provinces submitted to imperial Rome, then though the invasion of the territory of a free people may have been unjustifiable yet we may look upon the offence as having been expiated by good government. On this principle we may say that though we had no right to take India yet we have a right to stay since we have proved that the people benefit by our presence there. Indeed the possibility of our holding India justifies our holding it. For what are some

70,000 white troops against a population of some 250,000,000? Permanent conquests of large and populous territories are only made possible by the just government of the conquered.

Appropriation of the territory of barbarous peoples

But, it may be said, highly civilised nations do things which it is possible to regard as utterly reprehensible, not only with impunity, but with great advantage to themselves. They take the land of barbarians from its owners, and then it often happens that the barbarians are unable to withstand their firewater and their diseases. It is difficult to defend this appropriation of huge tracts of territory on principles of abstract justice. The Great Powers negotiate and divide among them what belongs to others. Everyone's claims, except the owner's, are considered. And thus many picturesque peoples pass away, while others become half-Europeanised, and, being exposed to novel conditions, adapt themselves to them in ways that are not admirable. But though these appropriations are often indefensible, yet they only hasten an inevitable process. It is impossible to put a stop to all trade between civilised man and savages, and it is trade and intercourse, the introduction of the vices of civilisation without its virtues, that begins the process of exterminating or unmanning the savage. Moreover, I believe Europeans have not cut off any stock that showed promise of a noble development. The Duck-billed Platypus is as capable of developing into one of the nobler mammals as the native Australian of evolving a civilisation of his own. I believe that in no part of the world has the European invasion nipped in the bud any promise of noble things. It may be that this thought has been in the minds of many educated and humane people, and has prevented their feeling against the appropriation of the territories of savages from becoming very strong.

But perhaps there has been a more powerful motive in the hope that they would adopt Christianity and conform to civilised ways of life and thought. Often we must divide the nation into two: one half appropriates, the other finding the appropriation a *fait accompli* insists on good government. If all this is borne in mind, it is very difficult to feel that England, the greatest appropriator of the savage man's property, has thriven by injustice.

We have as yet found no proof that injustice thrives, or that the evolution of civilised man can dispense with religion and moral principle. On the other hand, it is easy to show that the enslavement of savages brings evil upon their owners. The institution of slavery is degrading to the masters as much as to the slaves. And when the white man's conscience begins to work, and he declares the man of colour shall be free, then he finds himself confronted with a political question far more difficult than any question we in England have to deal with. The abolition of slavery does not settle the black problem. So that here a terrible retribution has followed the foul inhumanity of which our race was guilty in the days of the slave trade. Whether the punishment has fallen where it is most due is another matter.

The individual citizen

We will now go on to consider the question whether the power of a nation to cope with its enemies depends to any great extent on the sincerity of the religion of the citizens. We must proceed on the assumption that moral principle for large masses of men must have a religious foundation, and that success in war is impossible without honesty in officials. In fact, as far as honesty is concerned, the case seems to require no proving. But there is in many persons a belief that the best soldiers are either fanatics or else hard-swearing, ungodly ruffians. "Cromwell's fanatical sectarians," they would say, "and the lawless failures of civilisation that formed the rank and file of the East India Company's white army, were about equally good soldiers. The English soldiers under Wellington, too rough a lot to be managed except by flogging, were fighting material almost impossible to match. Our sailors in the Napoleonic war were an utterly godless set, and yet of unsurpassed heroism in battle. The French revolutionists abjured Christianity, and yet sent out armies that eclipsed the grand traditions of the old *régime*."

These arguments show a certain amount of discernment and require investigation. A nation, like a man, is a combination of qualities. A strong nation is strong because of some of its characteristics and in spite of others. Our navy in Nelson's time was not irresistible because the men were treated as brute beasts, were pressed into the service—Englishmen, Irish revolu-

tionists, foreigners, even including Frenchmen—and flogged for every offence. Its strength was largely due to the fact that the better officers got rid to a great extent of the old system of brutality and appealed to the men's patriotism. Certainly Nelson's success was in a great measure due to this. On the other hand, the mutinies that nearly ruined us were traceable to the view that brute force is everything in discipline. In the same way in the days when flogging was generally regarded as the only means of controlling the private soldier, there were some regiments, and those among the best, where it was reduced to a minimum. In fact, something beyond physical force is wanted to make armies strong. But to insist upon this is not necessarily to undervalue the exuberance of animal vigour that characterises the men who fight the nation's battles. At present, however, I wish to lay stress upon the necessity of something beyond this, a splendid thing though it is, if an army is to inspire terror in its enemies. And this something, I believe, cannot be entirely dissociated from religion. An individual fighting man may be a despiser of all such things. But being so, he is merely a machine and a machine requires to be set in motion. To use an Americanism, he must be "enthused." National spirit (alive in others though not in the man we are imagining) supplies the motive power, infecting even those who are indifferent and apathetic. And national spirit, if entirely sundered from religion, is found before long to decay. For without religion a nation tumbles to pieces, the power to restrain vice and selfishness being wanting. National spirit will check such undermining influences as long as the enemy are at the gates. Its influence wanes during the piping times of peace.

State building

In the first half of the eighteenth century England seemed to be sunk in mere brutishness, without religion or national spirit. The revival of our greatness came with Chatham's revival of nobler principles, with his protest against political corruption and jobbery. And it was not long before this that the religious movement began that is associated with the names of the two Wesleys. Ever since that time there has been in progress a strong national movement never divorced from religion, which

has for its aim the raising of the lives of the mass of the people to a higher level. It becomes apparent from this, how national a thing religion is. "Italy," said Mazzini, "is itself a religion."[1] This enables us to see the secret of the success of the French revolutionary armies. They were inspired by a patriotism which had some of the chief characteristics of a religion. But the speedy downfall of revolutionary France shows that there must have been some great defect. Patriotism that has no religious basis is apt to degenerate into mere jingoism, and then to evaporate. But religion that does not include as part of itself an exalted patriotism lacks one essential element. "Look almost where you will in the wide field of history, you find religion, wherever it works freely and mightily, either giving birth to and sustaining states or else raising them to a second life after their destruction. It is a great state-builder in the hands of Moses and Ulfilas and Gregory and Nicholas; in the ruder hands of Mohammed and many another tamer and guide of gross population down to the prophet of Utah it has the same character, the same too in the hands of the almost forgotten Numas and the propagators of the Apollo worship who laid the foundation of the Roman and Greek civilisation, and of the pilgrim fathers who founded New England."[2] With these grand words, worthy of the writer of them, and true of all communities since and before the dawn of history, I bring the discussion of this branch of the subject to a close. Enough has been said to show that religion has much to do with the survival or disappearance of nations.

V

THE PROCESS OF MORAL EVOLUTION AMONG CIVILISED MEN

Natural Selection and morality

Natural Selection cannot be got rid of. The progress of wealth and science lessen the stringency with which it acts on the individual, *i.e.* the standard of physique that is necessary

[1] I quote this from Seeley's *Natural Religion*, p. 195. [2] *Loc. cit.* p. 197.

for survival is lower. But there remains a standard, to fall below which is fatal. In the same way morality founded upon a religious basis has come in to check vice before it has proceeded far enough to entail elimination and to check tendencies which, however harmful to the State, may bring material prosperity to the individuals in whom they show themselves. Natural Selection remains in the background, but not so very far off. Religion and morality make their appeal to a man, and if that appeal fails he falls a victim *eventually* to his own vices, or is removed by certain indirect means of elimination that Natural Selection has at command for those who are deficient in morality, deficient, that is, in any of the qualities that are essential to social life. As to self-indulgence, there is no need to say more than has been said already. Science does its best to save a man from the consequences, but in the end, if there is persistence, elimination must follow. But as to the social virtues and the way in which they are fostered by evolution in its present course much remains to be said. The anti-social sins all spring from want of respect for the rights of others. Dishonesty in its many forms is, probably, the most ruinous of all. And what we wish now to discover is the process by which honesty, as we find it in civilised states, has been evolved. Now there are two ways in which we can imagine this possible. A body of religious principles might be accumulated and these might be in successive generations preached with intensified effect, each generation perhaps adding something, each pointing to the venerable character and prestige of the truths insisted on. But such influences working alone could do but little, a fact that becomes clear when we reflect that exhortation is not creation: it can only awaken and stimulate qualities that are already present. In other words, morality is not transferable. Preaching and example can develop what is good in a character, and cause the starvation of what is bad, but they cannot implant new tendencies. This is not said with a view to detract from the value of preaching by example or precept, but to show that there must be a basis of natural disposition on which the influence of religion and moral principle may work. This

natural disposition, civilisability as it may be called, is the slow product of evolution, due to the constant elimination of all or many of those who were unfitted for civilised life. The amount of such elimination is much greater than would be suspected. I shall try to give some idea of it, but it must not be expected that statistics will help us much in a question of this kind. Still they are not entirely wanting. Civilisability results from the elimination of the uncivilisable

In England in 1896 the gallows accounted only for twenty deaths, that is, less than one per 1,000,000 persons living. But the total of homicides was 301, and a number of the guilty persons were, of course, practically eliminated by imprisonment for a long term of years. The suicides of the year were no less than 2656, at the rate of 86 per 1,000,000 of the population. Some of these may be put down to the strain and worry of some departments of modern life, some to uncivilisability. Disgrace, owing to the outbreak of some tendency that ought not to exist in a high state of evolution, thieving for instance, may produce a feeling of depression or self-disgust that may account for some of this long and melancholy roll of suicides. These twenty-six hundred were somehow out of place in England, many of them because of moral defects.

The prison must account for an enormous amount of elimination, if we could only trace its indirect effects. To have been in prison is a frightful stigma, and we cannot but infer that this influences sexual selection. A man who has been in jail is not likely to be an acceptable suitor; still less is a girl thus disgraced likely to find a husband. How far sexual selection operates towards the evolution of morality it is hard to say, but certainly it is not without influence in that direction. A man of orderly life is preferred, for instance, to a drunkard. How can it be otherwise among the poor who can hardly fail to have seen among the homes of their neighbours something of the misery of drunkenness? Or how can the rich fail to realise it?

It is very hard to estimate the indirect causes at work. Out of the total of deaths in England in 1896 no fewer than 19,745 are attributed to "debility, atrophy, inanition." Of this large number nearly the whole were deaths of children

under five years of age, and more than 18,000, of infants in their first year. Now, in the light of the facts revealed by the Society for the Prevention of Cruelty to Children it is impossible to doubt that a very large portion of these deaths *were due to starvation*, and the starvation must in many cases be due to moral defects in the parents. Consider next the deaths of those over five years of age put down under the same head, "debility, atrophy, inanition." There are only two hundred and seventy-one. But does anyone suppose that this is anything approaching to the annual total of deaths indirectly traceable to starvation or insufficient food? The fact is that insufficiency of nourishment and filthy surroundings bring out tendencies to disease that would otherwise remain latent. And thus thousands of deaths caused by underfeeding are credited to various diseases. But the underfeeding is due very often to want of character in the parents or in the persons themselves. Those who are thoroughly steady and dependable get work and are fairly well fed—a fact that makes philanthropy difficult. Hunger is often not so much a cause of deficient morale as a symptom of it. It is on the class that lives in squalor and on the verge of starvation, that disease, and especially consumption, falls most mercilessly. So that we have a chain of causation. Defect of character causes poverty: from proverty result squalor and deficiency of food: disease is aggravated by squalor and hunger. Thus many of the victims of disease are eliminated because they or their parents have not the moral qualities which civilised life requires.

Alcohol

Alcohol is a potent force that has much to do with the development of race-character: as I have already shown it promotes physical evolution. When drinking is the fashion, a physical constitution strong enough to resist the ill effects of a large amount of alcohol is for most of the male sex a condition of survival. But there is another way of resisting alcohol: it may be used in moderation or altogether abjured. When this is the nature of the resistance moral evolution takes the place of physical. It is, as a rule, a moral not a physical test that alcohol applies to young men belonging to the upper

social strata. A good deal has been heard lately about a recrudescence of the habit of drinking at the universities. It is difficult, however, to regard it as anything but the backward swirl of a little eddy in the stream that sets towards sobriety. Already there are signs that a race of men is arising who are unequal to the heavy potations of their grandfathers or even such amounts as their fathers made light of. As the generations pass, we may expect that this defect, with its accompanying superiority, will proceed further. Englishmen will be less able to stand alcohol, and also less tempted by it.

The process at work is not an entirely simple one. Physical and moral evolution by means of alcohol are always proceeding side by side. Alcohol supplies a physical test to which numbers submit themselves. But as the power of self-restraint increases, more and more persons avoid the test. And thus the average of physique is lowered through the strengthening of moral principle. But there are always a number of persons exceeding the amount their physique can withstand. Alcohol maintains the physique of the nation while it develops power of self-restraint.

But it eliminates others besides those whose love of it is excessive. Its victims are often men or women who have come to grief owing to some other defect of character, and who strive to drown their cares. Thus many defects, many moral contortions, eliminate indirectly, using alcohol as their agent. Here we are in dim regions which can never be illumined by the light of statistics. Could we penetrate the gloom, we should see numberless tragedies of individual lives, first some incipient failure or deviation from the right course, after a while loss of hope, and finally drink sweeping away the refuse of society. And so alcohol appears as the benefactor of the community. Unfortunately, as everyone knows, its methods are such as to bring untold misery, and not only on those who succumb to it. But this must not blind us to the services it renders, and among them we must rank high its weeding out of bad tendencies, which, however injurious to society, might otherwise wait long for the penalty which they deserve.

We have now seen on what an enormous scale elimination for

defective moral character takes place. The prison, the hangman, suicide, starvation, disease, alcohol, sexual selection are all at work. We are driven, therefore, to the conclusion that the evolution of the race is tending mainly to morality. Among those who have the necessary minimum of physique it is moral character, more than brain power, which settles the question of survival or non-survival. I am quite aware that the whole of the moral improvement that has passed over England of recent years is not to be accounted for by elimination of the bad. That is a process which builds a very firm foundation, but it works very slowly. There have been forces at work which are quite distinct from evolution, but which co-operating with it strengthen and advance morality. To the consideration of these forces the next section will be devoted.

VI

THE EVOLUTION AND THE PROGRESS OF MORALITY

Moral evolution is brought about by the elimination of those in whom anti-moral tendencies are strong. But moral advance in a nation is due only partly to this, though Mr A. Sutherland traces it to this source and no other. The advance made depends very largely on the atmosphere of thought in which the people live, and what this atmosphere is, depends to a great extent on human effort, not on any automatic process of evolution. The enlightened minority of the population are able to make an environment which fosters good tendencies and represses bad ones. This influence is a growing one. Societies dealing with particular evils are able, in ways that, till recently, were impossible, to make themselves heard throughout the length and breadth of the land. The tone of the better minority sets in motion a wave that presses into squalid corners, even the most out-of-the-way.

The drink question brings out clearly the distinction between progress and evolution. Drink is combated vigorously by

preaching and exhortation, and thus many who are constitutionally prone to it are prevented from falling victims. The minority who have reached a higher plane struggle by every means in their power—and not without success—to raise the lives of their fellow-countrymen. And as a result there is undeniable progress. Yet it would be folly to deny the necessity of the slowly working process that prepares the ground for the reception of a higher ideal of life. This truth has a very practical bearing. Supposing that a strong-willed minority were to banish alcohol from the country and make temperance compulsory, there would result an absence of drink but not temperance, and the process of moral evolution would be checked. This point has been very clearly brought out by Mr Archdall Reid.[1] If we allow it due weight, we must shrink from advocating any system of compulsory abstinence. At the same time there is no reason why drunkenness should be made so easy for the poor, no reason why better pleasures should not be put in their way to act as counter attractions. Alcohol will long continue to claim a large quota of victims annually and so help to evolve a race strong to resist its temptations. But it is to be hoped that less degrading pleasures will be brought more to the people's notice and become more easily obtainable than at present, so that the taste for them may grow and compete with the love of drink. The two means of dealing with the great evil may well work hand in hand.

The atmosphere of thought in which the people live has as much to do with their lives as evolution, and this atmosphere derives its character very largely from the great men whose guidance the nation accepts. Among these, great poets and thinkers must rank high and also the really great among men of action. The claim of the latter is so indisputable that it can only be matter for wonder that great soldiers or sailors are not admitted to the Comtist Calendar of great men. It is in war that you most often see the utmost nobility of human nature concentrated in a moment of self-sacrifice, uncalculating and complete. Certainly magnanimous men of action must be counted

[1] See his book *The Present Evolution of Man.*

amongst the prophets of a nation, since one great deed is better than many sermons. Men are all hero-worshippers to some extent and they try to mould themselves after their heroes. Tennyson and Browning, Nelson and Nicholson, Arnold and Kingsley, these are all names of men who have helped to make our mental environment, our ways of thought and the whole tone of modern England. This point is well brought out in Mr Bagehot's *Physics and Politics*, which no one should omit to read. But by no means everything depends upon the leaders. An inspiring appeal is of little avail if the rank and file are not of the right stuff. Higher ideals would avail but little unless supported by the slow but irresistible advance of evolution.

There is never any noble development of virtue without predisposition, never on the other hand without a stimulating environment. Heroism in fact is born in the blood, but it will only thrive in a congenial atmosphere, in a society in which great deeds are venerated. Hence the enormous importance of education, if we include under that term all the influences brought to bear on a human being from his birth onwards. To insist on this would seem a mere commonplace, only worthy of a copy-book, and yet it is a fact that requires driving home. Not only is there a feeling among Englishmen that they can trust to heredity to pull them through, but even when the influence of early environment is fully recognised there is a danger that the training of children may be entrusted to the wrong persons. No doubt our over-confidence in unimproved natural endowment is waning through somewhat bitter experience, but when we turn to consider the education of the masses we cannot fail to see great dangers looming ahead.

Evolution, it must not be forgotten, produces only a predisposition, a soil in which noble thoughts will take root and grow when properly planted and tended. And, obviously, their own parents are the persons to whom should be intrusted the first implanting in children of the love of good. The whole course of human progress has been made possible only by family life. Very little will result from grand talk about grand ideas unless there is affection on both sides—in child and instructor.

And these conditions are present in perfection (if we pass over altogether exceptional cases) only when the teacher and learner are parent and child. This fact is an utter condemnation of the socialistic system that proposes that the state should undertake the entire education of children. No salaried official, however zealous, is likely to succeed in awakening the love of noble things. I do not wish to maintain that home education can, except in very rare cases, meet the demands of modern life. The point on which I insist admits of no dispute: the love of all that is good and honourable, the hatred of what is base and loathesome, should be instilled, as far as possible, during childhood and at home. Socialism

Hardly less ruinous than socialism is polygamy. It is the ruin of family life, and makes the higher civilisation impossible. Among some species of wild animals, polygamy, as I have shown, has hastened evolution, and no evil consequences have attended it. Yet where the offspring require much care, pairing is the rule, and the male works hard to help his mate in the work of foraging and nursing. Among man, as soon as morality became the dominant factor, polygamy was out of the question. Polygamy

As in wild nature, it grew up where the feeding of the offspring was an easy matter. It is common in sunny southern lands where food is easy to get, and clothing is only a matter of decency, so that the multiplication of wives and children involves no great difficulty for the well-to-do. It means but a small increase of expenditure. In northern lands polygamy has been checked by the necessity of hard work to support even one wife and family. And with family life in the north have grown up certain virtues, which seem to be not highly developed in the south. The north, as we affectionately think of it, is

> "Dark and true and tender,"

while the south is

> "Bright and fierce and fickle."

We can see now the connection between moral evolution and moral progress. Great thinkers make an atmosphere of higher thought. In this atmosphere the individuals who compose the Inter-dependence of progress and evolution

nation have to live, and there is a gradual elimination of those to whom the atmosphere is utterly uncongenial. And thus evolution follows in the wake of progress, and is the antecedent condition to further progress.

For this process, however, the circumstances are often unfavourable. The nation becomes hidebound with foolish customs, and fails to free itself, so that there is neither moral progress nor moral evolution. What the special conditions are on which progress depends, I shall discuss in a later chapter.

Chapter XI

INTELLECTUAL EVOLUTION

I do not intend to attempt to trace the course of evolution from the dim consciousness of the one-celled organism to the crowning triumph of Shakespeare's intellect. But I wish to give some evidence that the highest brain-power may have been evolved no less than bones or thews and sinews; we have not before us a problem which need stagger an evolutionist. I propose also to discuss the question whether civilised people are still advancing in intellectual power.

Consciousness

At the lowest rung of the ladder, in the simplest protozoon, there is, we have reason to believe, consciousness, however dim. We may feel sure that the human brain is akin to brains of lower organisation and that all its faculties, however exalted, owe their grandeur to the ennobling of originally humble powers that are found in the lower animals no less than in man.

Memory

In the case of memory we can see how this has come about. Memory is due to the association of ideas. The brain is a very complicated organ with a number of different centres communicating by means of connecting fibres. Thus ideas become connected, and any particular idea may be re-awakened by the awakening of another which at some time has become linked with it in the mind. To take an instance, cowbells may become associated in a man's thoughts with Swiss mountains and a whole host of holiday pleasures. The notes of such a bell will call up visions of snow mountains with all the experiences connected with them. We remember the mountains when we hear or see the bell. The stimulus is reinstated, the idea is rung up—a term I adopt from Professor Mark Baldwin—by an associated idea. In the case of a protozoon no less, a stimulus may be reinstated so that the creature will repeat its behaviour

of a previous occasion. Give it the same food and it will take it or reject it as before. We do not call this memory, because there is no *indirect* setting of brain centres to work. Nevertheless it is of the nature of memory. If we once recognise that when we recollect a thing, it is because something reminds us of it, the fact becomes clear. A knot in a pocket handkerchief through association makes us remember, say, a letter due to a friend. A "warning to cyclists" may recall a bad smash. There is somehow a reinstatement of a stimulus, and this takes place equally in a protozoon. The difference lies in this that with a complicated brain machinery and a variety of means of communication with the outer world, there are many ways in which the reinstatement may take place. Under these circumstances we have what we call memory.

In the lowest brain there is raw material from which very noble things can be manufactured. But if we try to trace the process of manufacture, there are great gulfs which it is difficult to bridge. There is the difficulty, for instance, of abstract ideas. From what rudiment was evolved the power of conceiving roundness, for example, apart from a particular round thing? And are any of the lower animals capable of even a glimmer of an abstract idea? These are questions which it is very easy to ask and very difficult to answer. For if it is a hard task to trace the course of evolution with anatomy to help us, it is a hundred times as hard when from the conduct of, say, an elephant, we have to infer his thoughts.

Though I assume that the highest faculties that men have are found in rudimentary form in the lower animals, I do not wish in any way to depreciate the greatness of man's intellect—his power of concentrating his attention, of imitating and learning, his power of abstract thought, his originality. He is a being of infinite versatility who meets the buffets of circumstances with ever new shifts and contrivances, and not only this, but he probes the universe, learns its laws, and philosophises on the thousand facts that he discovers.

"*What a piece of work is man! how noble in reason! how infinite in faculty! In form and moving how express and*

admirable! in action how like an angel! In apprehension how like a god! the beauty of the world! the paragon of animals!"

High-flown as this passage is—Hamlet, as is his wont in his talk, fairly flings away the scabbard—it is impossible to feel that there is any exaggeration in it. When we think of the noblest men of the noblest races we feel it to be true. But when we turn our thoughts to the lowest of savages we seem to be thinking of beings of an entirely different order.

Yet it may be shown that the gulf between the savage, who can count only up to four, and the highest product of civilisation, is not nearly so wide as is often supposed, and when once this truth is grasped, it is not so difficult to imagine the evolution of intellect. On the question of comparative brain power most divergent views are held. On the one side we have those who consider that there is very little difference between man and man in respect of intellect; education, environment, they say, is everything. On the other side are extremists who tell us that inborn mental power is all in all, and education counts for next to nothing. Both views may easily be proved to be wrong. Bring to bear on a negro boy all the resources that the educationalist can command, and the results will be but poor. Take a boy of first-rate ability and put him in a meagre environment, give him the kind of education that starves the brain; he will not advance far. But we must be careful when glorifying education, to explain the word in its widest sense. It must be taken to include all the influences brought to bear on the person in question in childhood and boyhood till maturity is reached. When education is thus defined it is difficult to overrate its importance, provided we do not fall into the error of imagining that it can create. It can only develop and make the most of the qualities that are born in the man. Education puts nothing in, it can only stimulate the growth of what is there already.

Brain capacity and education

If we bear this in mind we shall not be likely to fall into the mistake of considering that education is everything, and that natural endowment is of no importance. But it is equally fatal to assume that the great inequality of intellectual attainment is due entirely to inequality of innate capacity. Mr

Attempt to measure brain power

Francis Galton finding that the senior wrangler in one particular year obtained 7500 marks, whereas the "wooden spoon," the lowest in order of those who appear in the honour list, succeeded in gaining only 300, comes to the conclusion that the senior wrangler had twenty-five times the innate ability of the "wooden spoon." It is very doubtful whether differences of intellectual power can be represented numerically, but, allowing that, it would seem that there is a mistake in the calculation. Assuming that the two men, the highest and lowest in the list, worked equally hard, and had equally good lectures and "coaches," it is nevertheless difficult to believe that they gained equally by their teaching. It is probable that the native capacity of the clever man was multiplied by instruction more times than that of the dull man. Even if this was not the case, yet the gulf between the two was enormously widened. Suppose that the capacity of the one was represented by 1, and of the other by 12, and that education multiplied it in each case by 20. Then their powers are raised to 20 and 240 respectively, and the difference between the two is no longer 10, but 220. But there is reason to believe that the capacity of the more powerful brain is more times multiplied than that of the less. This will, I believe, become clear when we consider the way in which intellectual advance is made.

Originality

The art of teaching consists very largely in giving copies or models for the pupil to imitate. If the particular model is too difficult, an explanation, as we call it, is given. But this explanation is either part of the former model, presented separately, so that it may be easier to imitate, or it is a different model the imitation and understanding of which will make the one originally presented easier. We are, in fact, making use of the instinct of imitation, supplemented by a whole system of rewards and penalties. The pupil is exhorted to learn from the model put before him. The word imitate is not very frequently used. He is told to think out problems for himself and has it impressed upon him that mere knowledge of book work, however necessary, is nothing compared with original work. And when he accomplishes a rider in Euclid he is filled with a pride

that no successful tackling of a proposition is able to produce. But however important it may be for the educator and his pupils to distinguish between original work and mere learning, yet the two things are not so far removed from one another as is generally supposed. When a proposition is learnt and intelligently written out, there is imitation. When a problem is worked out without help, there is an application of what has been learnt to new circumstances: in this sense the work is original. Thus originality, as a quality of the brain, would seem to be the power of bringing together the ideas formed in different brain centres. The original man sees how a fact in one field of knowledge bears upon a fact in another. If Sir Isaac Newton had kept such commonplace events as the falling of apples in a compartment of his brain completely walled off from that in which he kept his mathematics, he might never have made what is generally considered the greatest of his discoveries. This becomes clear when we think of men—and they are not so very uncommon—in whom this power of combination is almost entirely wanting. A fact in their brain is barren. It does not ring up a number of other facts, jostle among them, and at length find its proper place. On the contrary, in a brain in which the various centres are always in communication, each new idea has to *justify itself. If it is* incongruous, it is ejected, as a man is *blackballed for a club.* If not ejected for incongruity, it may, nevertheless, not over-easily harmonise with the ideas already established there. Much readjustment may be necessary and the old ideas may undergo profound modification through contact with the new comer, just as a society may be modified by the admission of a new member of strong and pronounced character. And the outcome of this crowded jostling life within the brain may be the emergence of ideas that appear definitely new, or in other words, of original thought. Such would seem to be the way in which thought advances. Objection might be raised to this on the ground that mere combination cannot possibly lead to an advance. But to argue thus is to be the slave of metaphor. Law reigns throughout the universe, and thought "advances" by bringing

the various facts of observation into harmony with one another. Newton found that the resistance of air to a body in motion increased as the square of the velocity. In this fact we have learnt to find the secret of a bird's flight. Advancing a step further we can see that only by rapidity of motion can man solve the problem of aerial navigation. The problem of evolution is now being attacked. Malthus observed that there was a limited amount of food and that there was a struggle among men to obtain a share. Darwin applied this to the whole field of animated nature. He saw further that breeders modified animal forms by selection. He looked out over the face of the earth to see if there was anything that occupied the breeder's place, selecting the better forms and developing new breeds, and he saw that the struggle for existence might be held to do the work of the breeder. An original man is, therefore, if this view be correct, a man who has an exceptional power of seeing the bearing of facts upon other facts, and when he discovers a relation between ideas or between objects — strictly, there is no distinction to be made—that has hitherto remained unnoticed, he gets (or deserves) credit for originality.[1]

We may now return to the subject of education and the way in which it multiplies congenital brain power.

Intellectual machinery

The training of a pupil's mind consists in putting models before it for imitation and encouraging him to make use of them under varying circumstances and apply them in new fields. Many of these models may be regarded as pieces of machinery which enable the mind to do work which it would otherwise find enormously difficult or impossible. Our system of counting, Mr Benjamin Kidd has pointed out, is nothing but a mental tape measure. We arrange the objects we are counting along a line of mentally pictured figures, every tenth number being written big in order to help the mind's eye. When we borrow 10 and carry 1 we are equally making use of a piece of mechanism. As we proceed in arithmetic, our progress is made possible by the use of new machinery, into the mysteries of which we are

[1] On the process of learning see Professor Mark Baldwin's *Mental Development in the Child and the Race.*

step by step initiated, and are told to call each machine as we are introduced to it by the name of a rule. If, as is possible, we are told that no rule is wanted and that we have "merely to think," this only means that we have already learnt the use of the machine required and that we have now to apply it under slightly different circumstances. In other words, we have to be, in a mild way, original.

But I have not yet mentioned what is, perhaps, the most remarkable characteristic of such pieces of mechanism. *The understanding of one makes the understanding of another possible.* You cannot find a lowest common multiple, unless you have first learnt the art of division. You cannot attack algebra with success unless you have made some headway with arithmetic: it is foolish to begin trigonometry without some knowledge of geometry. The man, therefore, who finds a particular piece of mechanism very difficult to understand cannot advance to the study of other pieces of mechanism, the understanding of which is impossible while the one that has defeated him remains unmastered. And yet, perhaps, more advanced machines are not much more puzzling, in some cases possibly not at all more puzzling, than the one which proved insurmountable. But the stupid man, thus nonplussed, is at the end of his tether. The clever man gets over the difficulty and finds at his disposal a number of other machines, from the use of which the stupid man is debarred. Turning these to good account, he advances into new worlds of thought, while the man who started to race with him no longer even limps behind, but has put on his coat and looked out for some humbler occupation. All this may possibly be made clearer by a simple illustration. Imagine two men one of whom can walk five and the other four miles an hour. And imagine that the power to walk five miles an hour admits to the use of a bicycle, by the aid of which fifteen may be covered in the same time. The difference between the two is no longer one but eleven miles. And further suppose that to the man who can ride fifteen miles an hour on a bicycle is permitted the use of some other machine—railway train or flying machine—from which the mere pedestrian is

debarred and which makes sixty miles an hour a possibility. The superiority of the better man in miles per hour is now fifty-six instead of one. It can hardly be said that this illustration overstates the difference in the amount gained by the very clever and the very stupid from the records of the discoveries of great men, the machinery, that is, which makes further advance possible.

From this it would seem that it is not so easy to measure the comparative superiority in actual brain power of the senior wrangler to the "wooden spoon." Assuming that such a thing can be represented numerically, twenty-five times may be altogether too low an estimate. But, whatever may be correct, it is quite clear that education multiplies the power of the better brain more times than it multiplies that of the inferior. The man of great calibre enters into a glorious inheritance. All that previous ages have discovered is open to him and his original work is an addition to a pile already heaped mountain high. And as knowledge advances it is clearly of importance that all that has been already attained should be made easily accessible. Otherwise the preliminary work to be done before new fields of thought and observation can be explored will be too burdensome. Already the mass of it appals the imagination.

The brain capacity of savages

We are now in a better position to compare the capacity of savages with that of civilised men. It is matter of common knowledge, how limited is the arithmetic of the savage. The native Australian can count only up to four, at any rate he has words only for the first four numbers, Mr Benjamin Kidd says only for the first three. The Andamanese, when not educated by Europeans, have no words for numbers above two, though they can count up to ten by striking the nose and saying "this also." But now schools have been founded in the Andaman Islands and up to the age of twelve or fourteen young Andamanese boys are as intelligent as any other children.[1] Of Australian children we have similar accounts: when taught by Europeans they show great intelligence up to the age of puberty.

[1] I give this on the authority of Mr Frederic Boyle. See *Macmillan's Magazine*, November 1898. See also Tylor's *Primitive Culture*.

During three consecutive years an aboriginal school in the colony of Victoria stood highest of all the state schools, obtaining 100 per cent. of marks.[1] The Maoris retain their intelligence longer, taking honours at the Universities and on the average outstripping lads of European stock. But after this the European draws ahead.[2] In the same way the negro boys in the United States are sharp and bright up to the age of puberty, when taught by Europeans. These facts are beyond dispute, and there is a great mass of literature on the subject to which the reader can easily refer.

Very different conclusions are drawn from these facts. On the one side we have Mr Francis Galton weighing the intellectual capacity of the natives of Damara against that of his spaniel, and inclined to decide that the spaniel had the advantage. On the other we have Mr Benjamin Kidd quoting with approval a writer in the *Contemporary*[3] who says "nine hundred and ninety-nine parts out of the thousand of every man's produce are the result of his social inheritance and environment." No doubt Mr Galton was wrong in measuring the comparative *attainment* of the savage and civilised man and assuming that the gulf between them in *natural capacity* was equally great. But it is also true, I think, that the importance of innate intellectual power is much underrated by some theorists. The children of savages who compete successfully with children of European extraction soon get to the end of their tether. Moreover they have their intellectual pabulum served up to them in a peptonised state by their teachers. It has yet to be proved that they are capable of original thought or of making discoveries or inventions, and without this power in some of its members a nation cannot advance.

Intellectual advances due to accumulation of knowledge, not to evolution of higher intellectual power

Having thus protested against undue depreciation of intellect, we may agree with what Mr Benjamin Kidd so stoutly maintains, viz. that human progress depends on "social efficiency" even more than on intellect; that we make progress mainly through the accumulation of knowledge, each generation adding a little

[1] See Mr Benjamin Kidd, *Social Evolution*, chap. ix.

[2] See Mr F. Boyle, *loc. cit.*

[3] Mr E. Bellamy, *Contemporary Review*, July 1890, "*What Nationalism means.*"

to the sum and enabling the next to start from a point a little further advanced. This fact was long ago grasped and expressed in eloquent words by Huxley: "Man alone possesses the marvellous endowment of intelligent and rational speech whereby in the secular period of his existence he has accumulated and organised the experience which is almost wholly lost with the cessation of every individual life in other animals: so that he now stands raised upon it as on a mountain top, far above the level of his humble fellows."[1] Huxley is here comparing man with the lower animals, but what he has said would be equally true of civilised man in contrast with the savage. Civilised nations during many thousands of years have piled up a mountain of knowledge gained by experience, observation and thought; from the top of this pile we now survey the world and are apt to flatter ourselves that our superiority to the savages below is due solely to our own greater capacity. The humbler and more correct view has now been made clear to us, and we are able to recognise the magnitude of our debt to former ages, and also the duty of adding something in our turn to the mountain of knowledge.

There is no disputing the general proposition that intellectual advance among civilised men is due mainly to the accumulation of knowledge and to better methods of presenting facts to the learner for assimilation. Not only do we start a little ahead of the previous generation, but we have at command better machinery for the solution of problems: discoverers have, in fact, framed better formulae for our use, and each of these formulae is a piece of mechanism that enables us to make further progress. With such aids a man, though his brain has reached its full development, may still make headway. Taking advantage of machinery forged by the ingenuity of others he may press onward, may range over fresh fields of thought and see the meaning of facts that before seemed meaningless, long after advance in actual intellectual power has become for him, through physiological fact, an impossibility. And when we reflect on this, the question inevitably suggests itself: is intellectual pro-

[1] *Man's place in Nature*, p. 112.

gress in the race identical in character with the progress of the man whose brain has reached maturity? Or does the race, intellectually speaking, advance simultaneously along two lines? In other words, is it only by means of accumulated knowledge and better methods that many men are able to perform what may seem greater intellectual feats than ever their forefathers could, and to modify their environment in a way that was never achieved before? or is there also a selection of the more clever for survival, and so a gain in brain-power properly so called? In the same way when bicycling records are "cut," we may fairly ask the question: Is it that the men, as well as the bicycles are superior to what they were, or is it only the bicycles?

The history of inventions throws some light on this question. One man may get the credit, in popular estimation, of inventing the steam engine, but the invention is really due to a number of workers each of whom added something. And it is impossible to weigh the comparative merit of those who produced engines that, perhaps, would not work at all, because of some slight defect, or that were of no practical use, and that of the man who presented the crowning triumph to the eyes of the admiring world. Wireless telegraphy, when first discovered, is nothing but an interesting laboratory experiment. It then comes out into the glare of public fame as a means of communication. But the man who puts the finishing touch is no greater, necessarily, than the man who is the first to grope his way towards the dimly seen possibility. Apply this principle logically, and the man who discovers a better means of shaping flint instruments, or a better means of hafting them, or an easier and quicker way of producing fire is not, necessarily, lower in the scale than the man who discovers an improved method of telegraphy. In every case the difficult thing is to add a little to existing knowledge, to improve a little upon the existing practice. It is possible sometimes to estimate the advance made by one man, and applying this test we must, I believe, rank Newton above any man that has appeared on the earth since. This does not look like progress in brain-power, unless it be argued—and I think it hardly can be—that Newton is too

recent, as an evolutionist counts time, to be separated from men now living. At least it may be maintained that, if there were any progress at all, men of equally great capacity would have appeared. Mr Gladstone held that the great men of the middle ages were quite on a par with, or even superior to, the greatest intellects of the present day.

Evidence from literature

Literature may help us to a decision. It does not depend nearly so much as science upon accumulation. Nevertheless every writer, consciously or unconsciously, is a borrower of the thoughts of other writers. Shakespeare is greatest of such borrowers, though when the work has passed through the crucible of his mind, it is so much better than the crude original, that we cannot help feeling that the borrower deserves more credit than the originator. In addition to such traceable borrowing, the world is full of ideas which once emanated from some man's brain and have now become common property. These are combined and worked up into new shapes by literary men, so that they too, like men of science, are heirs of all the ages. But in literature there is not, as in science, a step-by-step advance; the dependence of a writer on his predecessors is less direct and obvious. When, therefore, Shakespeare is weighed against any writer of the present century it is more truly an estimate of comparative brain-power than when a comparison is drawn between two men of science who lived at different dates. And Shakespeare outstrips by a great deal all writers of more recent date. Let the reader who doubts this read *Hamlet* once more.

Small demand for high intellect

We may now approach the subject from another direction. Is there reason to believe that the progress of the human race has been due, to any great extent, to an elimination of stupid individuals or tribes because of their stupidity? It is easy to see that many animals—foxes for instance—depend upon their cunning for survival. It is likely, therefore, that there will be progress in cunning through the continual elimination of the stupid. But when men came to live in tribes together, when they had language at their service, and still more when writing had been invented, the cleverness which a man required, was

only such as would enable him to assimilate what facts his nation had learnt by experience, and which survived through tradition or written record. Each tribe, to hold its own against rivals, would have occasionally to produce a genius who would advance a little in knowledge beyond the stage already attained. But in order to accomplish this, he need not be a greater intellect than others who preceded him. In fact, a new path of progress having been opened up, progress through accumulation of knowledge, would not the old path be deserted in favour of the new? In reflecting on this, we cannot help recalling how much a son of savage parents may learn when put under European instructors.

The musical sense

Weismann's essay on *The Musical Sense* puts the case with telling force. Many animals have the nice discrimination of tones that is required in a great musician, and many have voice power enough to make fine vocalists. But yet they are not fine musicians. In the same way a man may have a fine musical ear and a fine voice, and yet, having had no training, he may be capable of nothing that is worthy of the name of singing. Music is, in fact, an art and has to be learnt like other arts. The vocal chords are a musical instrument and he who would sing must learn his instrument, just as an intending violinist must learn his. I am often struck by the utterly uncouth noises that proceed from English throats, when contrasted with the music of which many of them are capable with the help of proper training. And, no doubt, before they had emerged from savagery men's sense of hearing and their voices had been perfected sufficiently for the production, with the help of instruction, of splendid music. Is it not possible, then, that the brain long ago, having reached a standard high enough to assimilate the knowledge accumulated and make slight additions to it, ceased to develop further?

The hand

To illustrate this we may take the human hand and consider its past and its possible future. In long ages it has become a splendid grasping instrument; the thumb instead of being in a line with the fingers has become opposable to them. But no further improvement is likely, since whenever the hand fails to

do what is demanded of it, we equip it with some tool which makes the work easy. There is, therefore, now no selection for a make of hand that is a little superior in some way to the ordinary; the normal is good enough.

Elimination for stupidity

It is impossible, however, to maintain that among civilised peoples there is no elimination for stupidity. The extreme of stupidity is idiocy, and idiots leave no descendants. Above this extreme there must be a very low level of intellect which causes a man to fail in life. He is not likely actually to starve through want of brain, but he may be so badly off and may manage so badly that most of his children may die in infancy. This will depend very largely on whether the wife is as wanting as himself. When the wife has not the required minimum of wits it is quite possible that the death of a large proportion of the children will result even though the husband is better off in this respect. But stupidity is mainly eliminated through sexual selection. A workman does not want his home to be made miserable by a feckless wife. Beauty may sometimes rob him of his reason, but as a rule he will pick the shrewder (*ceteris paribus*) of two sisters. I believe such selection must go on to a very considerable extent, but a combination of qualities is expected and so it is difficult to discover what weight is attached to cleverness. Often the motives of the choice may be unknown to the chooser, yet it is none the less certain that a respect for shrewdness and a liking for vivacity must count for a good deal. But, even if we grant that there is a general demand for a fair amount of brain power, this is no evidence that a more intellectual race is being evolved. Evolution of higher powers takes place only when through a change of environment the survival standard is raised, otherwise elimination produces only fixity of type. Is there any reason to believe that cleverness is more wanted in the mass of men than two hundred years ago?

Competitive examinations

It is very easy to overestimate the amount of selection of intellectual ability that goes on in the present day. Men's perception of the facts is often overclouded by the large space which competitive examinations fill in their imaginations and by a misunderstanding of their operation. There is hardly need to

repeat that there is little or no foundation for the belief that the children of those who by study sharpen their intellects will be born with greater brain capacity due to the training to which their fathers have been subjected. Moreover, competitive examinations require moral quite as much as intellectual qualities. Fair intelligence if combined with perseverance and a power of sacrificing the present to the future will generally succeed, but great intellectual power, when unaccompanied by the required moral qualities, is apt to fail. And there is another factor necessary to success; education in England is still very expensive. If a boy is to pass a difficult examination, his father must have money. And money is obtained by a combination of qualities, by no means exclusively intellectual. Everywhere in civilised society we see that character is in demand. Moderate ability, no doubt, is wanted, but the great qualification for most careers is character.

Results of the achievements of intellect easily transferable

There is another strong reason for believing that a nation, to be successful, requires only a few highly intellectual men, while unless a large percentage of the citizens are men of sound moral principle it must infallibly decay. The very stupid are able to enjoy the blessings due to the labours of discoverers, inventors, and thinkers. An invention is often a contrivance by which an almost brainless man is able to do work which requires a great deal of brain. "You press the button and we do the rest," say the directions that accompany the camera. Thus instead of the skill of an artist, all that is wanted is to press a button! The men of a nation that has produced not a single mechanical invention, can in a day or two learn to use the finest rifle that mechanical ingenuity has devised. The results of the achievements of intellect are in a wonderful degree transferable. But moral ideas are not so easily transferred. If a sermon is to produce much effect, three conditions are necessary. It must be a good sermon, it must be preached by the right man and preached to the right people. The preacher himself must be a man of high character or his eloquence will bear no fruit, and his hearers must be persons so constituted that they respond to good influences. From this it follows that moral principle

depends largely on evolution; it requires the weeding out through many generations of those who are unfitted for social life. It requires also a code in which the highest moral law is embodied, and to which the preacher can appeal so that each generation as it grows up may be subjected to its ennobling influence. But neither a noble code, nor the best of preaching is by itself of much use, for morality consists in a postponement of a man's own material interest or his pleasure to the interests of others, and thus a lofty morality must be unacceptable to the mass of men till long-continued elimination has weakened or got rid of anti-social tendencies.

We may now contrast the demands made by a great preacher and a great mathematician of those whom they teach. The great preacher demands that his hearers should rise to a standard of life as high as, or not far below, his own. They must resist temptations that are as great or, perhaps, greater than his. The mathematician demands much less of his pupils. They must work through and understand his solution of difficult problems. But he does not expect the average pupil to come within miles of himself in original power. There is all the difference in the world between proving a proposition and merely understanding the proof when it is clearly set out. Euclid was a being of a different order from most of those who are capable of following his proofs. Original work is so difficult: to profit by the original work of others is, comparatively, so easy. The mass of men are able to gain a passable knowledge of science, if they have books and instructors at command: even the very stupid are able by the turning of a handle to work machines that only a genius could invent: and many of the fruits of invention and discovery are spread before all the world impartially. Thus the highest intellects work for the rank and file and the very fact that they can work for them must inevitably bring it about that the average brain power in a nation is not very high: the possession of a few brains of the first order is enough. The nation will not be conquered and enslaved because its average man is not a genius. But it is likely to be conquered if the average character of its citizens is low. It is not enough

that it should number among them a few men of exalted virtue. Such qualities as honesty must be ingrained in its masses. Honesty cannot be produced in a factory and served out like rifles in time of need. From which it follows that we must expect to find the successful nations of the world improving in moral fibre, while there may very possibly be little advance or no advance at all in intellectual calibre.

Yet some few intellects of the very highest calibre are necessary to the nation if it is to make progress and keep pace with other progressive nations. True, it is possible to do much by imitating everything that foreign nations invent. Have we not seen lately nations by this means producing great results? But there are disadvantages in the system which hardly need pointing out. And a nation requires other things besides mere mechanical inventions if its life is to be vigorous and healthy. In particular it requires a literature. The bard of the tribe brought out all the fighting quality of the warriors. Among the ancient Jews it was the prophet who stimulated their nobler aspirations and made and kept them a nation. Among modern nations the power of literature is difficult to overestimate. A writer who gives expression to what is in the minds of men doubles the force of the feeling. Of late years it has been possible to watch the steady growth of patriotism in England and it is to writers, whether poets or prose authors, that we owe most of this. But it is never possible for contemporaries to see the whole effect that a great writer produces. Literature, if it is of the highest kind, gains in power as time goes on. It is their literary heritage that has made national life possible to the modern Greeks. If they are not great as a nation, it is because of deficiencies which ennobling influences are powerless to make good. It is to their literature that the Jews owe the fact that they have not been lost among the nations. Shakespeare has done great things for England already, and if all English-speaking communities ever face the world as one united people, to him, more than to anyone else, it will be due.

Importance of literature

This suggests a question. National success requires only a moderate average of intellect, but an occasional mind of a really

high order. Can we expect that an occasional giant will arise amid a race of only very moderate stature? If we were speaking of physical stature, it would be unlikely that a man would arise who stood head and shoulders above all other men of the same nation. But in intellectual matters it is difficult to speak so positively. Even in physique the differences between man and man in a tribe or nation are very considerable. The corresponding differences in intellect are, as I have shown, enormously multiplied. The man of high ability enters into the whole rich heritage that great thinkers have bequeathed to the human race, and from this the inferior man is to great extent debarred. This is very largely true of literary men, of men of science it is completely and obviously true. It is as if we were to take two children, one weak, the other strong, feed the strong one on the best possible food, while the weak one was allowed only a poor and meagre diet. It is easy to imagine how enormously the innate superiority of the stronger would be increased by the time maturity was reached.

Summary

I will now briefly summarise my conclusions as far as I have been able to arrive at definite results.

(1) We must assume that in the lowest organisms there exist in rudimentary form all the faculties of the highest. From such rudiments intellect has been evolved without the implanting of any new powers from without.

(2) Though natural capacity in man varies enormously, yet the gulf between the highest intellectual attainment of civilised man and that of the lowest savage, is largely due to education and environment. This makes the evolution of the highest intellectual capacity conceivable. Great as it is, it is no greater than, developed only by the scanty means of culture at his disposal, might be needed by a barbarian or even a savage.

(3) There is much more selection in civilised communities for moral qualities than for intellectual power. An occasional man of genius is necessary to a nation, if it is to make progress, but this does not necessitate a high average of intellect among the citizens. Hence

(4) intellectual advance is mainly due to the accumulation of knowledge and improvement in methods of study.

Chapter XII

THE GREAT PRACTICAL PROBLEM

Recapitulation of three preceding chapters

I HAVE shown or attempted to show (1) that the tendency of civilisation is to reduce physical vigour; (2) that among men Natural Selection often fails to eliminate individuals for conduct that is ruinous to the tribe or nation to which they belong; from this failure of Natural Selection has resulted the evolution of morality and religion which have stepped in to save the human race from falling victims to their own vices; that now among civilised peoples evolution is working mainly towards a strengthening of the moral virtues; (3) that intellect, though there is no increase in actual brain power, is yet becoming more and more potent, since it has at its command an ever-growing accumulation of knowledge. Inventors are constantly making it easier to get food or minerals out of the earth, to turn raw material into useful appliances, and to transfer commodities from one part of the world to another. To the inventor the world owes an enormous growth of wealth, a very marked growth of leisure. Such changes demand a corresponding increase of morality and religion. When almost the whole energies of man were required to keep body and soul together, then the need of moral principle was not so great. All material progress necessitates an advance in morality, or else retrogression will set in, the nation not having sufficient virtue to stand the new strain. It is not difficult, if we pass in review the various nations that have hitherto ranked as progressive, to find some whose further advance seems to be arrested, not by a failure of intellectual power, but by a deficiency of moral principle.

Interaction of forces

But moral principle is not only the cementing force that holds society together. It tends also to hasten the process of physical degeneration. To také the most striking instance, men are

coming to trust not so much to their physical strength to save them from the bad effect of drink, as to their moral superiority to a degrading vice. Thus there is selection for moral rather than for physical fibre. It is possible, however, that as civilisation advances there will always be vices, which will act as alcoholism has acted, in their early days finding out mainly deficiencies of physique, later on deficiencies of principle. However this may be, we have to look elsewhere for the main cause of physical degeneration. The rapid progress of science, more rapid than ever before in the world's history, tends to make life easy even for the masses. Science works at the bidding of an ever increasing spirit of altruism which is horrified at the sight of suffering and makes every effort to save the poor from the hardships that poverty brings with it. If the present tendency continues, there will soon no longer be a hardy lower class from which the upper classes can be recruited. The conditions of life will be soft for all, and the whole nation will become adapted to its softened environment. Thus civilisation seems to be moving towards a precipice. The progress of science and altruism only hastens the rate of physical degeneration.

Physical degeneration

I have already pointed out how the process may be, though not checked, yet made slower. The basis on which the nation rests should be made as broad as possible. England has thriven in the past through the free admission of foreigners; there has frequently been an infusion of new and vigorous blood. And it is to be hoped that this will always be taking place in the future, though never rapidly or on a large scale. But the new-comers must be of Aryan race: we must have no hewers of wood or drawers of water sprung from some low and apparently unimprovable stock. The infusion of new blood, however, is no real remedy: it is hardly more than a palliative. To find a remedy we must look to an entirely different quarter.

A possible preventive

When morality first appeared in the world, its office was to prevent the ills that vice and the devious workings of human reason would have produced. Among wild animals Natural Selection deals promptly with all individuals whose instinct does not impel them to live in the way that is best for the species.

With men this is not so. The vicious man does not immediately suffer the penalty for his vices: his children may survive though he neglects them. Anti-social conduct may escape detection and remain unpunished. Thus a place is made for morality and religion. They intervene when Natural Selection retreats into the background and acts on the tribe or nation, not on the individual. I have re-stated this position instead of merely referring to it, because of its great importance. Grant that morality was thus evolved and, I believe, the conclusion towards which I am working follows.

The circumstances under which morality and religion first arose suggest a remedy for the evil that now endangers civilisation. Once more Natural Selection is retreating, is being driven further into the background. Comparative ease and comfort due to the advance of science and the growing spirit of altruism are likely ere long to be the lot of the large majority of civilised men. This, in itself a thing to be welcomed, must ultimately lead to physical degeneracy. Once more, in fact, the slackening of Natural Selection is bringing with it a danger similar to that with which men were confronted when human reason first began to work. Ages back, vice and anti-social conduct threatened tribes and nations with ruin, and morality and religion stepped in to save them, or rather those of them who could feel the value of such things. Now the increased softness of the environment threatens physical degeneracy. Since in both cases the danger has been due to the slackening of Natural Selection, may not in each case the remedy be the same? Morality and religion interposed to avert ruin when man's ancestors first became men: may they not equally step in now, annexing new regions hitherto not subject to them?

There is no need to go into details as to the method of their working. From the nature of the case, legislation can give but little assistance, though it may give some. It is only the education of the people to a higher morality that can be of much avail: in time the propagation of weakness and misery may come to be counted among sins. The services of sexual selection may be enlisted and may effect a great deal. I have shown

how among birds and the higher mammals it is able to raise a number of individuals above the minimum standard exacted by the environment.

All this may be chimerical. At the present time it certainly is. But, as the evil increases, it will gradually come to be less so. In any case, there is no force but that of morality and religion to resist the on-coming evil.

Chapter XIII

THE CONDITIONS OF PROGRESS IN CIVILISATION

The large majority of the human race unprogressive

Belonging as we do to one of the progressive races and not often looking beyond Europe and people of European lineage, we are apt to consider that progress is natural to the human race, and that when a nation stagnates there is something abnormal and almost unaccountable about it. Yet Sir Henry Maine long ago pointed out that only a small minority of the human race make progress, and that if we look at the peoples of India and China where the great mass of the race is found, what strikes us most is the fact that for centuries they have made no advance. Stagnation, not progress is the rule. But some definition of the word progress is necessary. Sir Henry Maine meant by it progress in civilisation, in science, art, morality, social condition, government. And in this sense his contention was undoubtedly true. But we must be careful not to extend the meaning of the word and assume, because we can see no progress, that evolution is at an end among the Chinese. It is probable that among them evolution is bringing about an increase of patient assiduity and an increased capacity for resisting disease. In the present discussion the word progress will be used to mean advance in civilisation and then no one will dispute the statement that among the great masses of men there has for centuries been little or none.

Physical vigour a necessary basis of progress

We must, of course, assume the existence of physical vigour as a basis if progress is to be made. In an earlier chapter I have shown to what causes tribes and nations owe whatever they have of physical vigour and energy. It is due to conflict either with other tribes or with hard physical conditions. Among southern nations the advance of civilisation and the establishment of a

settled government have generally led to loss of energy. War has ceased to be the normal state and the physical conditions of life have been easy. Consequently degeneration has set in and some half barbarous race has been able to defeat its more cultured rivals in spite of their superiority in the arts and sciences. Northern nations are better off since their climate has enabled them, to a great extent, to maintain their energy without the help of perpetual wars. But physical energy is only the necessary basis, and it has often happened that nations, though well enough off in this respect, have stagnated. How this comes about, I shall try to explain in this chapter.

An historical atlas to illustrate progress and stagnation

It would be very interesting to have a map of the world made with the regions occupied by progressive and stagnant peoples differently coloured. An historical atlas illustrating the same subject would be of the utmost interest. Supposing that red were adopted as the progressive colour, we should find in early times the banks of some great rivers, such as the Nile, a very brilliant red. Later on the colour would be found, not so much along river banks, but still near to water, always at no great distance from the sea, and not along every coast, but usually where the line of the shore is long in proportion to the area of land, jutting out in peninsulas, presenting also good harbours and navigable estuaries. And if in the spirit of prophecy a map of the world a century or two hence were added, we might see bright red extending over large continental areas formerly steeped in the black, or whatever the colour might be, of stagnation. Even in the map of the world of the present day it would be a striking thing to see the whole of habitable North America covered with the most brilliant red obtainable. Looking at and reflecting upon such a series of maps it would be difficult to avoid the conclusion that rivers and seas have something to do with progress. And, leaving the prophetic map alone, we might infer from the colour of the North America of the present day that some change had come about and that sea and river had less to say, in the matter of progress, than formerly. It would not be difficult now to advance a step further and see that ease of communication was the important

factor; that in the early times water offered the best or the only good highway for the traveller and the trader with his merchandise, whereas now the railway has made land travelling, if not so cheap, yet far quicker than travelling by sea. In short, intercourse, whether hostile or friendly, whether in the way of war or trade, is that which starts and maintains the movement of progress.

The fetter of custom

We may now refer to what Mr Walter Bagehot has told us in his *Physics and Politics*. In a very early stage of human society, it is very difficult to get men to obey, and without obedience no great success is possible for a tribe or nation. At this stage, therefore, men must be bound by the fetters of custom. The savage is the slave of custom, a fact which reference to any good work on primitive man will make clear. At one time the taboo system resulted in an entangling network of absurdities which went near to strangling society altogether, and which may have been fatal to many tribes who could not throw it off. But without taboo, would marriage and the rights of property have been respected? The fetters of custom were necessary at an early stage. It was equally necessary at a later day to shake off the many ridiculous accretions which as time goes on incrust an ancient custom, or even to shake off the ancient custom itself. The idea that

"One good custom may corrupt the world,"

is not a mere poetic fancy. But what is more likely to make men see the absurdity of their own customs than intercourse with other tribes whose customs are different? And what but war, and the dire necessity it brings with it, is able to stir the inertia of conservatism?

Intercourse, friendly or hostile, leads to progress

Referring now to the map of progress in early times I attempt an explanation of the progressive civilisation on river banks that preceded that which is found on the shores of seas. The first settlers on the Nile, for instance, must have formed a number of independent communities. The different customs and worship of different districts at a later date were no doubt survivals from this earlier period. Between these earlier communities there must have been war and trade, and this must have resulted

in progress. But as soon as they were all united under one government—this is said to have been the work of King Menes—not only was physical energy undermined by the infrequency of war, but the stimulus of competition was removed. A monotonous sameness overspread the land, differences were toned down or vanished and there was little or no opportunity for experiment. Then began the reign of that fatal enemy of progress, over-centralisation. Stimulus from without was, of course, not entirely wanting; there were fairly frequent wars with Asiatic peoples. But these were mostly at a lower level in civilisation than the Egyptians. There was intercourse too, with the Greeks, and the Greeks borrowed largely from the Egyptians when they themselves were far behind. But Egypt till late in her history came but little in contact with nations that were nearly on the same level as herself. The case was very different with the small Greek States. They spurred each other on in the race till Egypt was far out-distanced, and at length had to learn from her former pupil. What produces progress, if this view be correct, is rivalry between communities who are nearly at the same level of civilisation. When rivalry ceases through the formation of a strong central government, that moulds into one the rival states, then there is an end of progress. This it was that, in conjunction with other causes, produced stagnation in the Roman empire. The *Pax Romana* was, no doubt, a glorious thing, but it prevented the growth of other things that were far better. It is true that Christianity was not crushed. Its non-political character saved it from extermination till it had become so strong that it had to be recognised. And however remarkable the growth of the young religion in the Roman empire, it must never be forgotten that it was born among a people who had recently been struggling for freedom, who had never laid aside their national aspirations and who were soon to renew the struggle against their oppressors.

Its dull uniformity, the absence of rivalry, the disappearance of the compelling motive for strenuous exertion sapped the energy of the Roman world. And there was at work, too,

another cause to which I have already called attention—slavery with its inevitable consequences, loss of physical vigour in the governing class. There could not be a constant influx of vigorous blood from below since the mass of the workers were slaves with whom there was no intermarriage. A physically strong lower class living under hard conditions is essential if the governing class are to retain their vigour. From them they must obtain the unenfeebled blood that alone can save them from a failure of energy.

When we cast our eyes on modern nations we see new illustrations of the principles I have laid down. The battering of ideas from abroad against the incrustations of custom, the stress of competition, the fear of invasion, such are the causes that are stimulating nations and goading them to energy. On the other hand corruption flourishes when the state is by its circumstances removed from the perils that make good government a necessity. In the United States politics are treated as a game that need not be played over-scrupulously, but it is a remarkable fact that trade and manufactures do not suffer. In the sphere of trade there is keen competition not only within the States but with foreigners, and trading and manufacturing interests, therefore, are left untouched; to them bad legislation and corrupt administration would mean ruin. And now that the States have dependences, necessitating the maintenance of an efficient army and navy, it is safe to prophesy that there will be a higher morality in politics. It does not do to play at corruption when the lives of thousands depend on the efficiency of the public services. The Germans are a people who can never venture to forget that they have enemies at their gates, and I believe that in the German empire corruption has been reduced to a minimum. Italy may seem an exception to the rule, for her government is said to be the worst in Europe, if we except that of Turkey, and yet she is by no means free from the most serious dangers. However, the kingdom of Italy has not yet lasted very long and misgovernment is now bringing its inevitable results, discontent, possible bankruptcy and danger of disruption. It is clear that there must be either reform or an end of Italian uuity, followed

Modern nations

by the subjection of some parts of the country by foreign powers. In England has been witnessed recently a very striking phenomenon. Not long back the Conservative party were ready to make a game of politics and to sacrifice their principles for an immediate party gain. Home Rule for Ireland suddenly became a question within the range of practical politics and there was at once formed a Unionist party, of which the Conservatives formed the majority, and which was animated by an altogether higher tone because it had a definite principle to fight for and a very real danger to face. In France we see that it is only in the presence of national peril that the republic is capable of forming a strong and stable government. The necessity of organising an army and reforming the public services made them tolérate the wisdom of M. Thiers after the war of 1870.

Another illustration is supplied by facts that have recently become familiar to English people. England, very largely owing to her fortunate circumstances, had outstripped other countries in trade and manufactures. Then Germany appeared in the arena as a rival armed with all the energy that was born of the long-cherished ambition to overthrow the supremacy of France. This accomplished, she turned upon England, eager to conquer her in trade, as she had conquered France in war. Her strong national feeling has thrown itself into this new struggle, and she has certainly proved herself no mean rival. But do we not owe her a debt of gratitude for saving us from sinking into lethargy? Has not German competition put fresh life into many departments of English life? In particular we must thank her for showing that much is to be gained by developing as far as possible the intelligence of all the individuals that compose the nation. The old idea was that an educated and cultured few should guide the masses, for whom education would be an absurdity. This idea lingers only as a "pious opinion" in the brains of a few reactionary spirits. But the raising of the masses undoubtedly involves a danger which I propose shortly to point out. Before doing so, I wish to show once more how inimical over-centralisation is to progress. Where there is devolution, each district that is entrusted with the management of its own

Over-centralisation

local affairs may originate ideas; there will be *healthy rivalry*, experiments, and an effort everywhere to level up to the highest standard yet attained. It is difficult to overestimate what the United Kingdom has gained from the fact that Edinburgh has still retained something of the grandeur and importance of a national capital, and that the Scottish people, partly through the liberality of the terms of the Union have, up *till now, lost little* of their national character. The Irish people too, partly because they differ from the people of Great Britain, have contributed much to the common good, though unfortunate circumstances have made their contribution far smaller than it might otherwise have been. Whether the advantage of not being an entirely homogeneous nation is generally recognised, I do not feel sure. But I am certain the advantage of extending decentralisation further is recognised by very few. As to elementary education certain broad lines on which it should proceed should be laid down by the central authority. But, within the limits set, a county, or group of counties, ought to be allowed freedom to follow out the course that may seem best in itself or best adapted to its special needs. No doubt there would be much bungling, no doubt many crude experiments. But there would be experiments, and many of them; in that would consist one of the great merits of the system. And not only the experimenters themselves would learn wisdom, but other counties would profit by the failures and successes. The rivalry between county and county, so powerful already in other directions, puts this beyond a doubt. It is no use talking of the ignorance of the average county councillor of all such matters. The necessity of solving difficult problems is the great cure for ignorance and stupidity. On the other hand, nothing can be more deadening than the present plan, the forcing upon the whole country of a system elaborated by an overworked central authority.

Morality and religion

When we turn to the sphere of morals and religion, we find it still holds true that the great impelling motive towards progress is the necessity of opposing destructive forces. Among a strong people, determined not to go under whatever difficulties may confront them, new facilities for vice, sudden changes of

the conditions of life that threaten to bring demoralisation with them, new ideas that seem to undermine religion—all these help to form an atmosphere which produces moral vigour and purifies religion and gives it strength. When cheap spirits were introduced into England in the last century, degradation deep and general seemed imminent. No doubt the deadness of the English race during this period may be partly attributed to the new drink. But the struggle to resist the evil has, equally beyond a doubt, helped to raise the level of English life. Imagine the case of a people for whom vice, owing to conditions never hitherto realised upon the earth, was an impossibility: we should not expect to find among them any great zeal for virtue.

Another great seeming evil in England will, I believe, eventually turn out to be a blessing. Owing to the growth of manufactures the population has become concentrated in large towns. The life there is in many ways unhealthy. Physically the conditions are not so good as in the country, and the temptations to crime are far greater. When comparative statistics are produced, it is found that country folk commit fewer crimes in proportion to their numbers than town folk. And the moral drawn is usually this, that it is best to live a simple peasant life, for virtue evidently thrives better amid green fields and hedgerows. And yet, if England had continued as it was before the great outburst of manufacturing energy, if railways, steamboats, those "arch-abominations" among a host of minor horrors, had never been invented, it may safely be said that the English people at the present day would have been at a lower level morally than they are. The necessity of dealing with the new evils that have arisen has put energy into ministers of religion, philanthropists and legislators. It may be said that the evils have not been adequately dealt with. That is true, but there is no sign of slackening energy. There is much readiness to learn, a desire to avoid the mistakes of the past; there is no giving up trying. The better alternative has already been chosen. Not very long ago when these new and trying conditions arose, there were two possibilities: either the moral and religious force in the nation would prove equal to the strain

or, over-matched by their environment, our people would sink into vice and barbarism and lose even their material prosperity. But the latter possibility seems now to have become impossible.

Similarly what seem at first destructive forces may really exercise a purifying influence upon religion. When geology first made itself heard and came into conflict with the Mosaic account of creation, it was felt that a blow had been dealt at Christianity. But afer a time it was seen that no fundamental religious truth was assailed. When the theory of evolution gained a very general acceptance, what looked like a far more dangerous foe to religion had appeared in the field. Not only was the theory thought to be at variance with fundamental doctrine, but it seemed to favour a materialistic view of life. The alarm was very wide-spread, and extended even to men who were capable of thinking calmly and dispassionately. But the theory of evolution has done more than anything else to make clear a fact that ought to have been clear before: that there is in religion something indestructible, which no scientific theory can endanger. All that such a theory can do is to strip off unessentials, so that the progress of science, in reality, renders great service to religion, if only new discoveries or new ideas are properly faced. But if the new ideas are ignored or treated as dangerous enemies, then there ensues a separation of the nation into two rival camps, the scientific and the religious, than which nothing can be more disastrous.

The importance of a Code

To pass on to the consideration of another of the conditions, in the absence of which a nation is likely to stagnate and retrograde, we owe it to Sir Henry Maine [1] that the importance of a code framed when "usage is still wholesome" has been made clear. If there is not a code to refer back to, there is a constant danger that the national life will be overgrown and killed by unhealthy usage like a noble tree strangled by masses of ivy. There is no difficulty in thinking of examples among nations of arrested progress or absolute decline. On the other hand it is easy to recall instances where reference to a written code has saved the cause of progress. It need hardly be said that by

[1] *Ancient Law*, pp. 14-20.

the term code I do not mean necessarily a very elaborate system of law. Only it must be written, not orally transmitted and after the nature of oral traditions liable to all sorts of accretions, inseparable at last from the original nucleus. When a code is over-elaborated there is, no doubt, danger that it may check progress instead of promoting it. A half-artificial compilation, such as the laws of Manu, only in part representing ancient law as actually administered, doubtless, has more power to strangle than to stimulate progress. The earlier and simpler codes do not fall under this condemnation. The Twelve Tables did not prevent the Romans from advancing: their system of case law was essentially progressive and their code did not interfere with it. When there has been an incrustation of deadening custom, a look backward at a healthier past often suggests the idea of reform, and often, too, helps towards the translation of the idea into reality. Reference to the recorded wisdom of a past age makes clear the morbid tendency that has been at work, and the fact that there is an ancient code to which to appeal strengthens the hands of the reformer. In the cause of reform he appeals to men's conservative instincts. When Magna Charta has once been signed, political progress becomes comparatively easy for the English people. Not only is it an irreducible minimum: when the king violates it, it is re-enacted with clearer wording and added detail in order to make sure that he may not again play fast and loose with it. In other words there is a fight round a concrete embodiment of the people's rights. It is something definite to fight for. The people defend their charter as a regiment defends its colours, and, in the one case as in the other, defence leads to the acquisition of a great deal. In religious history we see the same truth still more strikingly illustrated. The reformer requires a written code to which to appeal for aid in combating the dead weight of human lethargy and conservatism. Of the Protestant churches it may be said that they constantly refer to the noblest of codes, while the Roman Catholic Church, under whatever grand words it may disguise the fact, resigns itself to the growth of unhealthy

custom. The Reformation, an event of which it is difficult to over-rate the magnitude, began with the disinterment of the Bible. Nor has the constant looking back to this prevented that adaptation to changed circumstances, which is an essential part of progress.

But all legislation when it becomes elaborate and attempts to regulate the lives and the business methods of the citizens is fraught with danger. Laws do not work as their framers intended. Even if a law proves beneficial at first, circumstances may change, while the law remains as it was and is no longer a help but a hindrance. Progress, therefore, necessitates further progress if the nation is not to decline. The more complex the life of the nation becomes, the greater the necessity of dealing promptly with new evils as they arise. *For England there is no possibility of standing still*: she must either move backward or forward. A nation of peasants, if its geographical position protects it from invasion, may long continue on the level to which it has attained, neither rising nor sinking. But when once it begins to advance to a more highly organised civilisation, it must not slacken or degradation will begin. **Danger of legislative interference**

We conclude, then, that progress originates from contact with other tribes or nations: war, no less than friendly intercourse, has been essential to progress in the past and there is every reason to believe that, were it not for national rivalry, always involving the possibility of war, stagnation and decline would set in. To prevent decline and promote progress a code is of the utmost importance, a code representing the best aspirations of the nation and round which all that is best in it may rally, when tyranny or accretions of unhealthy custom are strangling the national life. And this code should not be over-elaborate but should allow freedom to later generations to work out each its own system. **Summary**

When society has become complex, progress must be comparatively rapid if decline is not to take its place.

Civilisation, the evidence shows—I quote now the conclusions arrived at in chapters ix. and xii.—brings with it physical degeneracy, though the process is much retarded by our hard

northern climate, and as a state cannot be strong unless its citizens are physically vigorous, history will repeat itself and the most advanced nations will have to submit to others less enervated and bequeath their civilisation to them, unless a means of checking the evil is found. The only possible means would seem to be a further development of moral principle.

Chapter XIV

THE GREAT UNPROGRESSIVE PEOPLE

THE Chinese are a standing riddle. Other great civilisations of antiquity after reaching their zenith, have declined, have sunk into decay and disappeared. Chinese civilisation, if it has not reached its limit, has made a pause of enormous duration in its onward course. But it has not declined: it remains what it was ages back. Antiquity of the Chinese

Confucius was born B.C. 551. In B.C. 220 the great Shih Hwangti usurped the imperial throne, built the great wall, and swept away the feudal princes. In a remote antiquity competitive examinations were established and became the only gate of admission to the bureaucracy that surrounded the emperor.

The great Chinese inventions date from the distant past. Gunpowder was in use long before it was known in Europe. Printing also; with us it is, comparatively speaking, but a mushroom development of modern times. Canal-making is one of their ancient arts. Irrigation has been brought to perfection on mountain sides; every drop of water is pressed into man's service before it reaches the valley at the bottom. Though our methods of cultivation are in some ways far beyond theirs, yet they have developed a unique system, the success of which is undeniable. What comes from the soil must return to the soil. And the result of this circular system is that we do not hear, as in other countries, that the land is being exhausted. In another sphere they have achievements to show that are by no means despicable. The virtues of family life have flourished among them and it is easy to find examples of filial affection among the Chinese that it would be difficult to match in Europe. In 1854 the father and mother of one of the rebels were arrested. The son hearing that his parents were to be punished for his mis- Their strong points

conduct at once surrendered, with the full knowledge of what his fate would be, and was decapitated.[1] A Chinaman will think little of cutting a piece of flesh from his arm or thigh in order that this with other ingredients may restore his father's health.[2] Sometimes, to relieve their parents' pecuniary embarrassment, children voluntarily sell themselves as slaves.[3] The virtues of the Chinese are not conspicuous only in family life. *Their merchants are wonderfully honest.* *As servants they win* golden opinions. "We rarely believe in one another's Chinaman," Mrs Little writes, "but we are each of us absolutely convinced of the fidelity, trustworthiness, and shrewdness of our own Chinaman."[4] Servants don't shirk, the same authority says, because they are ill. And, summing up, Mrs Little describes the Chinese people as hard-working, good-humoured, kindly, thrifty, law-abiding, contented, conscientious. If they have all these virtues why do we reciprocate the contempt which they feel for us, and consider them, as they consider us, "outer barbarians"? The answer is not far to seek. Cleanliness is an integral part of European and especially of English civilisation, whereas the Chinese are slatternly, untidy, filth-loving.[5] The entourage of the walls of a Chinese city cannot be described in a book that is to lie on an English drawing-room table.[6] In Peking no arrangements whatever are made for sanitation or decency.[7] Add to this that Chinese officials thrive on corruption, that the honesty that is characteristic of the nation, vanishes in the presence of the temptations to which a mandarin is exposed and the most shameful double-dealing is the invariable weapon of Chinese diplomacy. Thus among the mass of the four hundred millions or so of the Chinese people we find great virtues obscured to European eyes by the nauseating filth of their towns and to some extent of their houses and persons, by the dishonesty of the government officials, and, it must be added, by the contemptible figure cut by their soldiers. Besides this

Their weak points

1 See *China*, by J. H. Gray, vol i. p. 83.
2 *Ib.*
3 *Loc. cit.* p. 234.
4 Mrs Little, *Intimate China*, p. 207.
5 *Loc. cit.* p. 348.
6 *Loc. cit.* p. 472.
7 See Mrs Little's account of Peking.

there is the abominable and senseless practice of foot-binding, to say nothing of infanticide which in some parts is common.

Reality of their civilisation

However offensive some of the ways of the Chinese may be to us, we must recognise the reality of their civilisation. That close upon four hundred million people should live in peace under one government, masses of them congregated in large towns, is a proof of civilisation of no mean order. But when we come to recognise the greatness of the Chinese, the question at once presents itself; if they have been capable of so much, why have they been capable of no more? Why have they stagnated for two thousand years? And then comes what is, I think, the more difficult question; why has not stagnation led to decadence? Why is there still much of the vigour of youth where we should expect senility? And lastly, why has there been no physical degradation?

Three problems to solve

Thus the great Chinese problem divides itself into three problems which we must deal with separately.

(1) Why for centuries past have the Chinese made no progress in civilisation?

(2) How, without advancing, have they been able to maintain their civilisation at the highest level reached?

(3) Why has the physical degeneration that, aided by other causes, ruined other ancient civilisations, not made its appearance in China?

To enable me to answer these questions, I am bound in fairness to state that I have no special knowledge of the Chinese. My only qualification is that I have read a number of books about them, with a view to studying the working of the principles, that I have found govern human evolution and progress elsewhere, under the conditions that obtain in China. The only assumption I have made is that Chinese nature is only a variety of ordinary human nature, its distinctive characteristics being the result of the peculiar environment in which it has been evolved. The ordinary Englishman is apt to say, "Oh! they are Chinamen!" as the only solution of any problem that China and its people may present. That the Chinese are what they are because they are Chinese, is to an evolutionist no explanation at all. Sir Henry

Maine assumes a limitation to the "ideas of which the race is capable"![1] But, since he wrote, our knowledge has advanced, and already he himself had discovered a clue that helps to explain Chinese no less than other civilisations. Taking then the facts of Chinese history and society as I have been able to learn them from books, I have applied the principles that have governed evolution among other races. But before proceeding to answer, as far as I can, the three questions into which the Chinese problem divides itself, I will mention the books that I have found most useful. First I place *John Chinaman*, by the Rev. G. Cockburn. The author was evidently a man of real insight, who was capable of appreciating the virtues of the Chinese, though some of their ways and modes of thought excited his contempt. *China, its Social, Political and Religious Life*, by M. Eug. Simon, is a valuable contribution to our knowledge. The author is so captivated by the charms of the Chinese, that he constantly, in comparison, depreciates everything French. In this respect he is unique as far as my experience goes. In all my other authorities, when they give their estimate of China and Chinamen, there recurs an insuppressible "but." "They have many virtues, but—!" "But their religion is a degraded superstition." "But their army is contemptible." "But their filth is intolerable." M. Simon makes occasional half admissions as to filth, and still contrives to admire. The Chinese have for him a glamour about them that hides their faults. And here I may remark that the man who has not been to China has an advantage in one way over the man who has. He can realise Chinese virtues without the noisomeness of Chinese ways perpetually obtruding itself upon him, to make him unappreciative and unsympathetic. Continuing the list of our authorities, I may mention *China*, by Archdeacon Gray, a mine of information; *New China and Old* by Archdeacon Moule, from which a great deal is to be learnt; Mrs Little's *Intimate China*, which gives a number of first-hand experiences, and is especially interesting on the subject of foot-binding and the movement against it that is now beginning among the Chinese; *China*, by Professor

Authorities on Chinese life

[1] *Ancient Law*, p. 23

Douglas in the *Story of the Nations* series, in which the facts of Chinese history are briefly and clearly given. I mention these as the authorities on which I have chiefly depended, not in order to depreciate in comparison the works of other writers on China that have not come under my notice.

I now proceed to the first of the three questions :— The first problem

(1) Why for centuries past have the Chinese made no progress in civilisation?

If the cause of progress is, as I believe, contact in war, trade and general intercourse with neighbouring nations, then there is not much difficulty in answering this question. Partly they have been shut off by natural boundaries, by the mountains of Thibet in the west, by deserts on the northwest. On the north, Hwangti (soon after B.C. 220) built the Great Wall to shut out invaders, and beyond these boundaries were nations living far inland under conditions unfavourable to progress and who lagged behind the Chinese in civilisation. The sea coast is very limited in extent considering the size of the celestial empire, and its capacity as a doorway for the entrance of new ideas was much reduced by the Chinese conception of all foreigners as outer barbarians. Heine describes the university beadles at Göttingen as existing in order to prevent the smuggling in of new ideas. But how much more effective for this purpose than any imaginable officials was the ingrained contempt for outer barbarians among the Chinese! But we have to account for the origin of the unmitigated contempt for foreigners, and the enormous stretch of land or ocean that separates China from Europe, the natural home of progress, at once comes to our aid. Everything that was great and glorious in China was of China's own making. There was nothing in the foreign countries they knew worth borrowing. Therefore foreigners were contemptible. Yet in their days of progress, the conditions that roused their reforming zeal must have been similar to those that stimulate progress now. Chinese civilisation undoubtedly attained to something near its present point through competition and general intercourse between a number of nations that inhabited its present home, rivers forming the chief highways of communication. It

is impossible to doubt this, but Chinese history seems to contain no record of such a period. In 2085 B.C., according to Confucius, the Emperor Yao came to the throne and "led all men to him," before he became "a guest on high." Enlightenment according to Confucius comes from enlightened despots. But there are good reasons for declining to accept his account of the matter. Even in his own day unruly princelings troubled the waters of Chinese life, and it is not unreasonable to assume that semi-independent nobles were preceded by independent sovereigns. In the free life of independent states, jostling one another, trying experiments and learning by their own and their neighbours' experience, and often bringing the merits of novel systems to the test of war, must have arisen the great bulk of Chinese wisdom, of which Confucius himself was the collector, not the originator.

Contact with Europe

When centralisation was completed, when Hwangti reduced the feudal princes, the immediate gain was enormous, but the great stimulus to progress had been removed. After that there is contact mainly with barbarian or half barbarian tribes. European influence, it is true, makes itself felt to some extent. In 1275 A.D. Marco Polo arrived in China and was received with favour at court. It seemed that China might awaken. After this the Jesuits obtained a footing in the Celestial Empire, grew strong in the sun of imperial patronage and showing a liberal spirit towards the existing beliefs and ways of the people seemed likely to exert a widely felt and lasting influence. Then came the great dispute as to the Chinese word to be used to translate the word God. The aged Pope in Browning's *Ring and the Book* pathetically laments the ruinous controversy.

> Alas!
> The converts use as God's name not Tien Chu
> But mere Chen or else plain Shangti
> As Jesuits seem to fancy politic,
> While say Dominicans it calls down fire.

Here is polemical violence with a vengeance! The question was whether a word was to be used which meant merely heaven or one which represented the Deity as a person. Without

venturing an opinion as to the right or wrong of the matter, I may say without fear of contradiction that the dispute much retarded the spread of the Roman Catholic Church. Since then missionaries have worked with much earnestness of purpose. But it may safely be said that the body of the people have not either through the missionary or the trader felt the impact of European ideas. Kang, the great Chinese reformer of to-day, has proposed revolutionary changes: he wishes that there should be an efficient police, sanitation, good roads, an improved system of cultivation, that the taxes should be honestly paid into the imperial treasury. The last proposal is revolutionary indeed. No wonder the Mandarins are up in arms! The young emperor, now deposed, lent a ready ear to all these suggested reforms, but the mandarins are ready to fight tooth and nail against them each and all, and the masses of the people have never heard of them. The movement that seems, as far as I can judge, to make most headway is the movement against foot-cramping. The piteous cries of the children during the weeks of the most painful stage of the process contend against the deep-rooted conservatism of the Chinaman, and there seems to be some hope that this abomination will in time become a thing of the past. Moreover the recent vice of opium-smoking that plays havoc with great numbers may eventually be productive of good. People will not engage a servant who "smokes," though they themselves indulge in the drug. It is evident that opium is felt to be a serious enemy and the necessity of combating this comparatively new evil may help to rouse the nation out of its lethargy.

Thus the artillery of new ideas and new influences is trying to batter the strongest citadel of conservatism that the world has ever seen. Here and there the outer wall has been scratched or chipped, it can hardly be said that a breach has been effected, though the near future is big with possibilities. Whatever the issue, there is good ground for my present contention. The Chinese have lived secluded from the rest of the human race, hence their long stagnation. On the rare occasions when an idea from outside has penetrated to them, they have set

it aside as a piece of outer-barbarian folly and have continued their way along the old track from which for centuries the race has never deviated nor wished to deviate.

The second problem

(2) How, without advancing, have the Chinese been able to maintain their civilisation at the highest level reached?

This is a far more difficult question than the first. To begin with we have to account for the extraordinary fact that the Chinese empire holds together. With no railways, with the very worst of roads, the huge organism might seem to have too slow a circulation to maintain life at all. But there are strong consolidating forces at work. In the first place there is community of language. All educated Chinamen — and education is very general — write the same character and through the medium of writing are mutually intelligible from whatever province they may come. The spoken language has broken up into a number of dialects that have diverged so far from one another that, practically, they may be considered different languages. There was no reason for surprise, when two Chinese nurses who met at Eastbourne could not speak intelligibly to one another. But this difference of speech does not reduce the binding power of the written language. That, as Mr Cockburn says, is as intelligible throughout China as the multiplication table is to men of different speech throughout Europe. The system of competitive examinations gives the people an interest in the government. Education is cheap and anyone who chooses may compete in the series of examinations which open the way to the highest appointments in the Empire. China is a true democracy: there is no class privileged by birth. With us much money is necessary to obtain the education without which success in an "open competitive examination" is impossible. In China the door seems to be really open to all who have moderate means. The three examinations, by passing which the first degree is obtained, are all competitive and, if there is any jobbery, it is at any rate insufficient to undermine the people's confidence in them. The third examination is held in the provincial capital. 'There may be only 30 vacancies and perhaps 2000 competitors, the

Community of language

Competitive examinations

survivors of the two previous ordeals, the cream of the intellect of the province which contains, perhaps, some 20,000,000 inhabitants.[1] In the examination premises at Hang-chow are 10,000 cells in which the candidates are confined day and night for three periods of two days each with an interval of one day between each session. The cells run in long lanes to the east and west of the broad paved path which leads through the area from north to south. Each lane of cells has a separate kitchen and an official cook."[2] And this trial of brain and endurance goes on during "the hot and most unhealthy days of September." Yet on one occasion at Hang-chow far more candidates presented themselves than there were cells into which to squeeze them.[3] The final struggle is at Pekin where the pick of all the provinces meet in the arena and the successful candidates are introduced to the emperor. What a portentous amount of labour, an Englishman is apt to exclaim, and all to produce a crop of corrupt mandarins! Why not get your corruption and incapacity by simpler means? Very natural questions those. But the merit of the system lies in this, that no Chinaman is debarred in his youth from the hope of rising to the top of the tree. If he cannot, it is his own incapacity that arrests his progress. What institution, then, is better calculated than this system of competitive examinations to make men supporters of the constitution and worshippers of things as they are? The only office not thrown open is that of emperor, and no Chinaman who knows how completely this august potentate is the slave of custom, if not of duty, is likely to covet the position.

The ancient books

The books which the competitors have to study date from a gray antiquity. They are the writings of Confucius, of Mencius who became a disciple of the grandson of Confucius and other sages, some of them of still more ancient date. Readers of these books seem most of them to end by being disappointed. Yet some of the *dicta* of Confucius represent a high morality. "Do not to others what you would not have others do to you." "I

[1] See *New China and Old*, by Archdeacon Moule, pp. 259-269.
[2] *Loc. cit.*, p. 263. [3] *Ib.*

have never yet met with a man who loved virtue as much as he loved pleasure," the inference being apparently that we must not slacken in our pursuit of virtue. Mencius "taught the original virtue of man and described human nature as surely disposed to good even as water is sure to flow downwards. Force alone and strong temptation can drive water upwards or drag human nature downwards."[1]

The Four Books and the Five Classics are a great storehouse of morality and wisdom to which the Chinese are constantly referring. Here, then, is another power which cements the nation together. All educated citizens of the celestial empire read and admire these writings of the wise of old, and the study of them produces a community of life, character and ideas which is more powerful than any freemasonry.

But not only do the ancient classics and the examinations in connection with them hold the empire together. They are, in addition, a powerful antiseptic that prevents the corruption of the national life. Nowhere in the world has there been a code of law or morals that has so long remained a living influence for good. Let it be granted that Chinese civilisation is infinitely below the European product.

"Better fifty years of Europe than a cycle of Cathay," expresses the conviction of all loyal sons of the progressive nations. But the Chinese have advanced a long way up the incline and if they have not slid down again towards barbarism, it must be owned that the fact is one to excite our wonder. And I believe it is largely to their great classical authors they owe it that there has been no decadence. It is an example of Sir Henry Maine's great principle, that codification should take place "when usage is still wholesome." It is a remarkable fact that there is no mention of foot-cramping in any of the Chinese classics. If you ask a Chinaman the reason why girl children have their feet cramped, he can give no good explanation. It is a custom. And the most probable way of accounting for it is that small feet were considered one of the points of beauty in women, and so they were cramped more and more till the

Foot-cramping

[1] *Loc. cit.* p. 247.

practice reached the present lamentable pitch. But can we believe that such a progressive unhealthiness of custom would have been possible, had the folly and wickedness of mutilation been impressed upon the nation by the ancient moralists? I believe too that the ancient oracles are silent on the subject of infanticide. It is exactly where they have left the growth of custom unchecked that it has become unhealthy. The code of morals has never been allowed to slumber. Throughout the empire it is perpetually being studied by all who wish to rank as educated men, or who hope that their talents may earn for them promotion to high office. The result has been that most pernicious tendencies have been nipped in the bud. Custom has become unwholesome only in cases where the incompleteness of the code has allowed it to grow unimpeded.

The family is the unit

The whole constitution of Chinese society seems admirably contrived to prevent disintegration. The family is the unit. There are no isolated individuals except those who have been expelled from their families for disgraceful conduct. This social unit, which we speak of as a family, often includes three or four generations living under one roof. The family council sit in judgment on offending members and may even inflict severe punishment. M. Simon mentions an instance of a man who had reached the age of thirty-two and who was the father of three children, being put in irons for three months by the family tribunal. Whipping, exile, excommunication may be thus inflicted without the intervention of the mandarin.[1] "On the outbreak of brigandage or the spread of disaffection every householder has to exhibit a list of his family at the door with the name of any other persons who may be staying with him."[2] When an atrocious crime is committed the law treats the family and not only the individual as responsible. Not forty years ago a Chinaman aided by his wife flogged his mother. The list of the punishments inflicted on members of the family, on the immediate neighbours, the graduates among whom he ranked, and the ruler of the district covers a whole page in Archdeacon Gray's account of the incident.[3]

[1] *China: its social, political and religious life*, p. 55.

[2] *John Chinaman*, p. 172.

[3] *China*, vol. i., p. 237.

Police

Some writers speak of police as non-existent in China. But this does not seem to be the case. "Towns are divided into wards and country districts into parishes, each having a headman and a constable who are appointed by the people with the concurrence of the magistrate."[1] Over every ten families is a tithing man.[2] The essence of the system is that the law does not deal directly with the individual but through a family or group of families, or a district. Crime brings disgrace not only on the criminal but upon his relations and even his neighbours. It is this system of mutual responsibility that makes it possible to carry on government with very few officials. M. Simon estimates that there is only one to 400,000 citizens. No wonder this strikes a Frenchman when he contrasts it with his own official-infested country! And the result of the system is that there is but little crime, what there is consisting mainly of petty larceny.[3] Chinese punishments are frightfully severe and yet the number of death sentences, according to M. Simon, is very small when the number of the population is considered.

Unimportance of the state

Thus law, as emanating from the State, plays a very small part in Chinese life. The tax-collector, like the magistrate and judge, is of much less consequence than in Europe. The taxes are very small in amount—only three francs per head, M. Simon tells us. All the importance of the family is so much withdrawn from that of government officials. The state is a comparatively unimportant institution and the rottenness of the government does not mean, to the same extent as it would with us, a rottenness of the national life. Within families the tone of thought must rise and fall. Within a particular family a great reformer may arise, a Confucius whose influence is limited to the circle of his own near kith and kin. In the little channels of life there must be variation in the flow, floods and droughts, but in the great channels the stream is uniform. There are no great legislative efforts, no great movements against social evils, because the evils when they arise are checked within the family. And the family life is perpetually reinvigorated by reference to the standard of the ancient moralists.

[1] *John Chinaman*, p. 150. [2] *Ib.* [3] *Intimate China*, p. 205.

Government interferes very little with the even tenor of the Chinaman's way. He is not harried by inspectors of nuisances. His house may be as insanitary as he likes to make it. If he chooses to drink water containing cholera germs, as he often does, the state has no objection. The municipal authorities may leave the streets in an absolutely pestilential state. Such evils may cause epidemics, but they do not tend to a disruption of civilisation as a Chinaman understands it. But the man who flogs his mother is striking at the very foundation of social life, respect for parents. On them, on the seniors in a collection of families, all government depends.

In the matter of property government interferes only when it considers the welfare of the people is involved. For the rights of the individual as such it does not care. It is the essence of the Chinese land system that every square yard of cultivable land should be cultivated. The land-tax, therefore, is on the *area* of land so that what lies barren pays as heavily as that which bears heavy crops. Proprietorship in land is to be encouraged; therefore a landlord must be left to collect his rents as best he can, and a very difficult job it appears to be. The tenant is the real producer and must not be robbed of the fruit of his labours. The rents, therefore, are very low, payable in kind, and must under no circumstances be raised. Picture a landlord trying to collect rents in kind over a large estate without police assistance! No wonder that peasant proprietorship is the rule! **Property**

Land is the ordinary investment for money except in the few great centres of commerce. The accumulation of capital on a large scale is beset with difficulties. Usury is very limited in amount because of the extreme difficulty of getting the interest or recovering the capital. A very high interest, as much as three per cent. per month, seems to be the rule, because the lender thinks it very possible he may never see the principal again. Thus the money-lender does not thrive; the set of things is against him. Pawnbrokers, on the other hand, are many and do a large business. Contrast with all this the ever-growing ubiquitousness of government in England and in **Usury**

English dependencies. Our system in India obliges us to support the money-lender through thick and thin. We dream of a system under which the poor ryot shall borrow at an easy rate from the state. It does not occur to us to leave the usurer to get his interest and his capital if he can.

Trade The difficulties of trade suggest to each district that it had better produce most of the commodities that it requires for itself: better still, if a man's own farm can give him nearly all he wants. There are local custom houses where the officials condescend to the use of fraudulent weights and measures. You cannot take your goods to market without squabbles and unfair exactions on the way.[1] Besides these local custom houses, there are the likin barriers to impede free circulation. The likin dues are collected for imperial defence: whenever goods are conveyed from one district to another they must pay toll, and the field for venality and corruption is a glorious one. The whole system is abominable, and yet it tends to prevent evils which European civilisation has to face and remedy. A man must stick to his land and till it himself, and then he is free from most of the evils that Chinese misgovernment allows. The whole world of official corruption can do little then to interfere with his happiness. And thus peasant proprietorship is encouraged even by the miserable incompetency and mismanagement of the government.

Religion Religion is decadent: superstition seems to be the proper name for what remains. If, as Mr Benjamin Kidd has taught us, religion is the power that binds human society together, why has not disintegration begun in China? It is not quite certain that disintegration is not beginning. But things move slowly there. The tendency of all the institutions is to cement and not to dissolve. The very tolerance by government of abuses prevents decay of the national life. Each family becomes to a great extent self-dependent. The necessity of honesty to social life becomes apparent to the large majority because the government does little to enforce honest dealing.

[1] *John Chinaman*, p. 137.

Now, were the legislature to step in and carry out reforms, were a ubiquitous and incorruptible police to be introduced, the government would have to continue on the path on which it had entered. It would have to persevere in its efforts to deal with new abuses, as they arose, instead of leaving the citizens to feel how intolerable life is made by certain forms of wickedness and so stimulating them to use the means at their command to extirpate the evil. The enforcement of right-dealing by ubiquitous state officials would inevitably lead to a weakening of family life. There would be a tendency for the individual to take the place of the family as the unit of Chinese society.

Ancesto worship

The religion of the people has been sufficient until now to prevent the disintegration of a society, the constitution of which reduces very greatly the tendency to dissolution. Moreover, it cannot be denied that the ancestor worship which is universal among the Chinese, is of the nature of religion. It may not be a really noble thing; it may lack, no doubt, some of the elements that are essential to religion, at least in its highest forms. Still it is an attempt to idealise family affection, and, therefore, we cannot but regard it as helping largely to cement Chinese society. And before leaving the subject, I must point out how a nation's need of religion increases with progress in civilisation. When almost the whole energies of the tribesman or citizen go to getting food out of the earth, there is but a small field for anti-social tendencies. China, measured by our European standard, has not advanced very far; her citizens get their living by patient manual labour. In her present circumstances she has a working minimum of religion enough to prevent disintegration. If her civilisation ever advances, and she has to face the dangers that beset European communities, with their great inequality of wealth, their labour and socialist troubles, then her ideals must be higher, or decadence will speedily set in.

The thi problem

We come now to problem No. 3: why has civilisation in China not produced physical degeneration? Here, as everywhere, we shall see how China's failures in one direction have helped her in another. In science there has for ages been stagnation. Mrs

Little tells us that new patterns in silks are brought out every year, but can it be said that there are any signs of real progress? Medical science is at very low ebb. M. Simon, who sees everything Chinese through rose-coloured spectacles, finds it admirable that a doctor receives only 2½d., or at most, 5d., for a visit! "Very dear at the price" is the inevitable comment when we read of his qualifications and his methods. He has never dissected, and knows nothing of anatomy. His method of diagnosis is by the pulse, and little else. His pharmacopœia contains some useful medicaments, but also a number of such things as tigers' bones, serpents' skins, dried centipedes, and toads' skins. A prescription is a very mitrailleuse, containing twenty or thirty ingredients; some may possibly hit the mark. As to sanitation, there is none. They live amid foul smells; the water they drink teems with bacteria. But the backwardness of medical science and the abuse of sanitation has maintained their physical strength. A Chinaman from childhood upward has by strength of constitution to hold his own against conditions not favourable to life. The doctor does not step in to help him to fight his battles. As we might expect, the infant mortality is great; only the sound in constitution pull through. Mr Cockburn tells us that he never knew a Chinese family in which ten children attained the age of twenty. When we talk of Chinese stagnation, the word must be understood as applying to their civilisation. As their population thickens it is probable that they grow in power of resistance to all the diseases which bad sanitation brings with it.

Slavery I have already pointed out how the institution of slavery was one of the chief causes, if not the prime cause, of the decay of the civilisations of Greece and Rome. In China, slavery is very limited in amount. It is true that some rich families have a number of slaves. But rich families are few: the mass of the population are peasants. Thus as the basis of society there is a huge mass of people who have to lead a life of toil and some hardship, and from this class the rich families can recruit their vigour. One of my authorities says that the children of mandarins are often delicate. This is probably due, in part at

least, to the same causes that produce loss of physical energy in the upper classes in Europe and necessitate continual recruiting from below. But in China the rich are too few in proportion to the huge masses of the poor to make the demand for unimpoverished blood an appreciable one. Practically we may leave the rich out of sight and consider the Chinese as a nation of poor men, of whom most are peasants.

Possibilities in the future

If we have succeeded in finding the true explanation of China's stagnation and of the long duration of her civilisation, we ought to be able to forecast to some extent the results of the penetration of European methods and ideas. Railways are being built and much of the country seems likely to be opened to commerce to an extent unknown hitherto. This will bring with it a gradual break-up of the simply organised peasant society. There will be new facilities for various vices and it may safely be said that the Chinaman's morality will not at first prove equal to the strain. But it is under the stress of constantly changing conditions that the moral character of a nation grows strong. It is with nations as with men. Trials bring out the best in them, if they do not altogether succumb. China may rouse herself from her lethargy to combat the evils that will before many years beset her. And it is possible that after much degradation she may prove capable of a higher civilisation. For of one thing we may be sure: the Chinese will not die out in the presence of European fire-water and European diseases. Fire-water they have of their own and are sober. And diseases their own way of life has braced them to withstand. Already some few show signs of assimilating ideas that come to them from Europe, and before long the torpid bulk is likely to be goaded into life by stimuli such as it has not felt for many centuries. The barriers have been broken down and China, no longer insulated, must play a part of some sort in the world. But it is possible that measures will be taken that may arrest progress while at the outset seeming to do nothing but remove great evils. The mandarins may be replaced by English or other European officials, and great will be the immediate gain: western honesty will take the place of oriental rottenness, for

though there are noble exceptions corruption seems the rule among mandarins. But the life of the nation will be sapped: the prizes of life will vanish from the eyes of her young men, and the people will not be educated by the necessity of managing their own affairs. The importation of honesty from abroad reduces the demand for the home-grown product. It is better for China to keep on trying to produce mandarins of high integrity though the failures much preponderate, than that she should be condemned as incapable of self-government and be treated like a child.

But hitherto China has made herself ridiculous when she has had to face European enemies or enemies who had adopted European methods. Is there any inherent incapacity in Chinamen that makes it impossible for them to organise an army? If they cannot do this, their undeniable courage will avail them nothing. They will have to put themselves in leading strings and the nation will sink into an apathy far more profound than that in which it at present lies. But it may be hoped that when the Chinese have once seen a better system, they may be able themselves to maintain it: they have honesty enough and brain enough: but in the past the spur of necessity has been lacking. The capacity of the nation has not for centuries been directed towards military affairs. Where the vitality is so great and the numbers so enormous, evolution has a grand field in which to work and he would be a bold prophet who would maintain that China will not *eventually* be able to take her place among progressive nations, when the character of the race has been modified by much elimination of those who will look only backward, and when European ideas have become slowly assimilated.